LANDAU ASSOCIATES

NOTICE OF CONSTRUCTION APPLICATION SUPPORTING INFORMATION REPORT

Microsoft EAT06 and EAT09 Data Centers
East Wenatchee Data Center Campus
Douglas County, Washington

January 19, 2024

Prepared for

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Date: January 19, 2024
Project No.: 1409015.030
File path: P:\1409.015.030\R\NOC Report
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TABLE OF CONTENTS

Page

FIGURES

TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

$\mu g/m^3$	microgram per cubic meter
AB	Assembly Bill
AERMAP	AMS/EPA regulatory model terrain pre-processor
AERMET	AERMOD meteorological pre-processor
AERMOD	AMS/EPA regulatory model
AMS	American Meteorological Society
ASIL	acceptable source impact level
BACT	best available control technology
CAT	Caterpillar Inc.
CATEF	California Air Toxics Emission Factor
cDPF	catalyzed diesel particulate filter
CFR	Code of Federal Regulations
CO	carbon monoxide
DEEP	diesel engine exhaust particulate matter
DOC	diesel oxidation catalyst
DPF	diesel particulate filter
EAT02	Microsoft EAT02 Data Center
EAT03	Microsoft EAT03 Data Center
EAT04	Microsoft EAT04 Data Center
EAT05	Microsoft EAT05 Data Center
EAT03-04-05	Microsoft EAT03, EAT04, and EAT05 Data Centers
EAT06	Microsoft EAT06 Data Center
EAT09	Microsoft EAT09 Data Center
EAT06-09	Microsoft EAT06 and EAT09 Data Centers
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
Facility	East Wenatchee Data Center Campus
g/kWm-hr	grams per mechanical kilowatt-hour
GEP	good engineering practice
HAP	hazardous air pollutant
HC	hydrocarbons
HVO	hydro-treated vegetable oil
km	kilometer
kWe	kilowatt electrical
Landau	Landau Associates, Inc.
Microsoft	Microsoft Corporation
MWe	megawatt electrical
m	meter

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

NAAQS .... National Ambient Air Quality Standards
NED .... National Elevation Dataset
NESHAP .... National Emission Standards for Hazardous Air Pollutants
NO_2 .... nitrogen dioxide
NOC .... Notice of Construction
NO_X .... oxides of nitrogen
NSPS .... New Source Performance Standard
NWS .... National Weather Service
O_3 .... ozone
PM .... particulate matter
$PM_{2.5}$ .... PM with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10} .... PM with an aerodynamic diameter less than or equal to 10 microns
ppb .... parts per billion
ppm .... parts per million
PSV .... potential site variation
PVMRM .... Plume Volume Molar Reaction Model
RCW .... Revised Code of Washington
RD .... renewable diesel fuel
RHD .... renewable hydrocarbon diesel
RICE .... reciprocating internal combustion engine
SCR .... selective catalytic reduction
SIL .... significant impact level
SO_2 .... sulfur dioxide
SQER .... small-quantity emission rate
TAP .... toxic air pollutant
tBACT .... BACT for toxic air pollutants
ULSD .... ultra-low sulfur diesel
VCAPCD .... Ventura County Air Pollution Control District
VOC .... volatile organic compound
WAAQS .... Washington Ambient Air Quality Standards
WAC .... Washington Administrative Code

1.0 EXECUTIVE SUMMARY

Microsoft Corporation (Microsoft) is proposing to expand its existing East Wenatchee Data Center Campus (Facility) in Douglas County, Washington (Figure 1). This document has been prepared to support the submittal of a Notice of Construction (NOC) application for emergency generators, under air quality regulations promulgated by the Washington State Department of Ecology (Ecology). The Facility is located at 875 Urban Industrial Way, east of East Wenatchee, Washington.

Microsoft currently has one permitted data center (EAT02) at the Facility. Microsoft operates 20 3.0-megawatt electrical (MWe) emergency generator sets, powered by a Caterpillar Inc. (CAT) Model C175-16 engine, and one 500-kilowatt electrical (kWe) emergency generator set, powered by a CAT Model C15 engine. Generators will be fueled by ultra-low sulfur diesel (ULSD) or renewable diesel fuel (i.e., renewable hydrocarbon diesel or hydro-treated vegetable oil). EAT02 was previously permitted by Ecology under Approval Order No. 21AQ-C255 First Revision.

Additionally, Microsoft previously submitted an NOC application for the EAT03, EAT04, and EAT05 Data Centers (EAT03-04-05), which include 60 3.0-MWe emergency generator sets and three 500-kWe emergency generator sets. The 3.0-MWe generators will be equipped with passive catalyzed diesel particulate filters (cDPFs) and selective catalytic reduction (SCR). The EAT03-04-05 NOC application and supporting information report were originally submitted to Ecology on October 19, 2022, and a revised supporting information report was submitted on June 16, 2023. The application is currently under review by Ecology.

In this NOC application, Microsoft proposes to construct and operate two additional data center buildings, EAT06 and EAT09 (EAT06-09), at the Facility with an additional 20 3.0-MWe generators and two 500-kWe generators. All of the 3.0-MWe and 500-kWe generator sets will be equipped with cDPFs and SCR. This project does not include a proposed increase in emissions for the generators located at the EAT02-03-04-05 Data Centers or any modifications to the equipment; therefore, New Source Review is limited to EAT06-09.

After full buildout of EAT06-09, the Facility will have a combined total of 106 generators. The proposed 22 generators will provide emergency backup power to additional server equipment located in the new data centers. A site map for the proposed development is provided on Figure 2.

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

- Twenty (20) Tier 2-certified 3.0-MWe emergency generator sets equipped with cDPFs and SCR
- Two (2) Tier 2-certified 500-kWe emergency generator sets equipped with cDPFs and SCR.

Additionally, Microsoft is requesting that Ecology complete an integrated review under Washington Administrative Code (WAC) 173-400-035 for two portable nonroad engines that may be used at the East Wenatchee Data Center campus in the future.

Consistent with the recent approach to permitting data centers in Washington, Microsoft is requesting Approval Order conditions based on worst-case emissions that are evaluated to allow permitting on a cumulative-hours basis rather than on a scenario- and load-specific basis. See Section 3.2 of this report for a detailed breakdown of runtime hours assumed for the generators.

Air pollutant emission rate estimates were calculated based on: Vendor-provided "potential site variation" emission estimates for oxides of nitrogen (NO_X), carbon monoxide (CO), hydrocarbons (HC), and filterable particulate matter (PM); sulfur mass-balance for sulfur dioxide (SO_2) assuming 100 percent conversion of sulfur in the fuel to SO_2; and emission factors from the following sources for toxic air pollutants (TAPs):

- The US Environmental Protection Agency's (EPA's) AP-42 Volume I, Chapter 3.4 (EPA 1996)
- California Air Toxics Emission Factor (CATEF) database (CARB; accessed February 2, 2023)
- Ventura County Air Pollution Control District (VCAPCD) Assembly Bill (AB) 2588 (VCAPCD 2001).

Microsoft is requesting flexibility to operate the generators at any load during maintenance and readiness testing events, consistent with the current permit for EAT02 (Approval Order No. 21AQ-C255 First Revision). Therefore, the pollutant-specific maximum emission rate under any load will be assumed for calculating the worst-case emission rates. These emission rates will be used in all operating scenarios that require full-variable load. In order to account for slightly higher emissions during the first minute of each engine startup, the estimated emission rates of pollutants associated with startup were scaled up using a "black-puff" scaling factor.

Based on the results of this evaluation, the recommended presumptive best available control technology (BACT) for criteria pollutants and toxic air pollutants (tBACT) is emission limitations consistent with the EPA's Tier 2 emission standards, which are achieved with combustion controls and the use of ULSD fuel or renewable diesel fuel (i.e., renewable hydrocarbon diesel or hydro-treated vegetable oil).

Microsoft is proposing to voluntarily install cDPFs and SCR on the 3.0-MWe generators at EAT06-09, and on the 500-kWe generators at EAT06-09.

Air dispersion modeling was conducted for criteria air pollutants and TAPs. The project included 22 proposed generators associated with EAT06-09. The 21 already-permitted generators associated with EAT02, and the 63 permit-pending generators associated with EAT03-04-05 were modeled as background sources; therefore, the air quality impacts associated with all 106 generators were evaluated. The results of modeling demonstrate that ambient criteria pollutant concentrations that result from operations at the EAT02, EAT03, EAT04, EAT05, EAT06, and EAT09 Data Centers, and other local and regional background sources, will be below the National Ambient Air Quality Standards (NAAQS). Additionally, the results of modeling demonstrate that ambient TAP concentrations that result from operations at the EAT02, EAT03, EAT04, EAT05, EAT06, and EAT09 Data Centers will be below Washington's acceptable source impact levels (ASILs), with the exception of nitrogen dioxide (NO_2) and diesel engine exhaust particulate matter (DEEP). Because modeled NO_2 and DEEP concentrations exceed ASILs, a second-tier health impact assessment has been prepared and is being submitted to Ecology under separate cover.

2.0 INTRODUCTION

Landau Associates, Inc. (Landau) prepared this document on behalf of Microsoft to support the submittal of an NOC application for installation and operation of new emergency generators, under air quality regulations promulgated by Ecology. Microsoft's East Wenatchee Data Center Campus is located at 875 Urban Industrial Way on Douglas County Parcel Nos. 22210910004, 22210920004, 22210920005, 22210920009, and 22210920006.

Microsoft operates 21 emergency generators as part of its EAT02 Data Center. Microsoft is proposing no increases to the operational limits and emission levels, or equipment changes for the 21 permitted CAT generators at EAT02.

Additionally, Microsoft previously submitted an NOC application for EAT03-04-05, which includes 60 3.0-MWe emergency generator sets and three 500-kWe emergency generator sets. The 3.0-MWe generators will be equipped with cDPFs and SCR. The EAT03-04-05 NOC application and supporting information report were originally submitted to Ecology on October 19, 2022, and a revised supporting information report was submitted on June 16, 2023. The EAT03-04-05 NOC application is currently under review by Ecology. These data centers will not incorporate cooling towers, but will use mechanical chillers, which do not emit air pollutants.

This NOC permit application proposes to construct and operate two additional data center buildings, EAT06-09, at the Facility with an additional 20 3.0-MWe generators and two 500-kWe generators. All of the 3.0-MWe and 500-kWe generator sets will be equipped with cDPFs and SCR.

3.0 PROJECT DESCRIPTION

(Section III of NOC application form)

3.1 Facility Description

Microsoft's existing Facility includes the EAT02 server building that is divided into five "colos." Each "colo" can include four 3.0-MWe gensets only, or four 3.0-MWe gensets and one 500-KWe genset. The portion of Microsoft's Facility that is pending permit issuance includes three additional server buildings, EAT03, EAT04, and EAT05. Each of the three EAT03-04-05 server buildings will be divided into five "colos." The proposed EAT06 data center building will be divided into three "colos" and EAT09 data center building will be divided into two "colos." The Facility is located at 875 Urban Industrial Way, approximately ⅔ mile north of the Pangborn Memorial Airport, as shown on Figure 1. A site map for the proposed project is provided as Figure 2.

3.1.1 Emergency Generators

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

Each generator will be operated only as an emergency generator, with generator usage and runtime hours limited to those for "emergency generators" by the federal New Source Performance Standard (NSPS) Subpart IIII, which requires that emergency engines satisfy EPA Tier 2 emission standards for emergency engines as defined by the federal regulations (40 Code of Federal Regulations [CFR] Part 89). Each of the proposed 20 3.0-MWe generators and two 500-kWe generators for EAT06-09 will be equipped with a cDPF and SCR. All Microsoft emergency generators will use ULSD fuel or renewable diesel fuel (15 parts per million [ppm] sulfur content).

Specifications and manufacturer-provided emissions data and emission control warranties for the CAT 3.0-MWe and 500-kWe generators are provided in Appendix A. The generators have the following specifications:

- Twenty (20) CAT Model C175-16 3.0-MWe emergency generators. The proposed generators will be EPA Tier 2-certified and will be equipped with cDPFs and SCR. The generators will have a combined capacity of 60 MWe.
- Two (2) CAT Model C15 500-kWe emergency generators. The proposed generators will be EPA Tier 2-certified and will be equipped with cDPFs and SCR. The generators will have a combined capacity of 1.0 MWe.

3.1.2 Nonroad Generators

Additionally, Microsoft intends to use two nonroad emergency generators to provide backup power in the event that a permanently installed and permitted engine or engines must be taken off-line for repairs. The generators consist of one EPA-certified Tier 4 Final 2.0-MWe CAT XQ2280 and one EPA-certified Tier 4 Final 1.0-MWe CAT XQ1140 (composed of two 0.5-MWe engines). Each generator is within an enclosure located on a trailer. When not in use, the generators will be stored off site at a designated work center located at the MWH Data Center in Quincy, Washington.

If one of the permanent and permitted stationary emergency generators located at the Facility malfunctions and cannot be used for its intended purpose to provide backup power to a data center building, the CAT XQ2280 and/or the CAT XQ1140 generators will be dispatched to the location of the malfunctioning stationary generator to be temporarily used as a replacement emergency generator until the permanent generator is repaired or replaced. Microsoft will not use the XQ2280 and/or XQ1140 at any coordinate-specific location for more than 364 days. Following repair or replacement of the permanent generator, the XQ2280 and/or XQ1140 will be returned to the designated work center for storage.

Microsoft is requesting that Ecology complete an integrated review under WAC 173-400-035 for the two portable nonroad engines; therefore, they have been included in the air dispersion modeling analysis documented in Section 7.

3.1.3 Renewable Diesel Fuel

Operating limitation 2.b.iv of the EAT02 Approval Order requires that all generators consume diesel fuel equivalent to on-road specification No. 2 distillate fuel oil (less than 0.00150 weight percent [15 ppm] sulfur). Microsoft requests approval from Ecology for the option to also use renewable diesel fuel that meets the requirements of ASTM International standard D975 and has a sulfur content of less than 15 ppm to power all generators at the Facility. A certificate of analysis for REG-9000 renewable hydrocarbon diesel (RHD) fuel is provided in Appendix B. Based on information provided by Ecology and vendors, RHD and hydro-treated vegetable oil (HVO) are considered forms of renewable diesel fuel (RD) and, therefore, the terms RHD, HVO, and RD are used in this application interchangeably.

All permitted and proposed generators at the Facility are CAT models. CAT has indicated that HVO fuel is considered a “drop in” replacement for petroleum-based diesel fuel and is approved for use in CAT engines. CAT provided a letter (Appendix B) indicating that HVO renewable fuel can be used to fuel CAT engines with comparable or lower emissions than that of the same engine model running on petroleum-based diesel fuel. CAT has stated that no change is required to potential site variation (PSV) emissions data based on the use of HVO.

Microsoft has tested RHD fuel at a data center facility outside of Washington State. Emissions were tested in a side-by-side comparison of petroleum-based ULSD and RHD. The results of that test show that emissions associated with RHD are similar and in some cases lower than emissions associated with ULSD. Due to the use of test methods that are not comparable to methods used by CAT to develop PSV data in a factory setting, the results of this study are not directly applicable to emission rates associated with the generators at the Facility. The study data are provided in Appendix B for informational purposes only.

3.2 Generator Runtime Scenarios

The emission estimates provided in this NOC application are based on emissions at “full-variable load,” which corresponds to the characteristic worst-case emission load of each pollutant. Emission estimates are discussed in more detail in Section 4.0.

On an annual basis, Microsoft requests that compliance with per-generator runtime limits be demonstrated by summing total actual operating hours for all generators in service and comparing that to the total number of permitted hours for all generators in service.

Generator operating scenarios for the EAT06-09 Data Center buildings are as follows[1]:

- **Monthly Maintenance:** Routine operation and maintenance on the proposed emergency generators will be conducted monthly up to eight times per year. Note, firing of each engine is required at least once per month to ensure with confidence that it is able to start up. Microsoft considered the alternative of not firing the engine every month, instead mechanically turning it over without firing it up, but determined that this would not provide sufficient confidence that it is capable of starting up when needed. This runtime activity will be conducted on one emergency generator at a time; therefore, more than one generator will not be run concurrently for this operating scenario. This operation will generally occur for 0.5 hours per month per generator with no load.
- **Quarterly Maintenance:** Quarterly maintenance operations will be conducted on each emergency generator up to three times per year. This runtime activity will be conducted on one emergency generator at a time; therefore, more than one generator will not be run concurrently for this operating scenario. This operation will normally occur for 0.75 hours per event but in some instances may occur for a longer duration. For modeling purposes, it was conservatively assumed that this operation will occur for 4 hours per quarter at full-variable load.
- **Annual Maintenance:** Annual maintenance operations will be conducted on each emergency generator one time per year. This runtime activity will be conducted on one emergency generator at a time; therefore, no more than one generator will be run concurrently for this operating scenario. This runtime may be conducted for a duration of up to 4 hours per generator at full-variable load.
- **Quinquennial Testing:** Every 5 years, two types of testing will be conducted at the Facility. During switchgear testing, each generator will be operated at full-variable load for up to 8 hours at a time with no more than five generators operating concurrently (up to four 3.0-MWe generators and one 0.5-MWe generator). During pad-mounted switchgear testing, each

[1] Note: The runtimes described are not intended to match the requested per generator annual operating hour limit because some of the requested Approval Order limits that are based on calendar days correspond to a 3-year average NAAQS compliance demonstration (i.e., they can occur for a greater number of calendar days in 1 year as long as they are reduced in an adjacent year). However, in any given year, Microsoft will not exceed the operating limits described in the requested Approval Order conditions.

generator will be operated at full-variable load for up to 16 hours at a time across 2 days with no more than five generators operating concurrently.

- **Unplanned Power Outage:** During a power outage at the Facility, all generators (i.e., permitted and proposed generators) will activate in order to supplement power to the server system and will operate at full-variable load, concurrently. Due to designed redundancy, generators will generally run at 80 percent load or less once the Facility is fully built out. However, in the unlikely case one generator fails to turn on, the remaining operational generators serving that same colo may operate at a load higher than 80 percent.
- **Generator Startup and Commissioning:** After a new generator has been installed, it will require commissioning. Commissioning occurs only once in the lifetime of each generator and consists of approximately 55 hours of operation for the first 3.0-MWe generator of each data center and 43 hours for each subsequent generator, including the 500-kWe generator. Commissioning consists of either 47 hours (first 3.0-MWe generator) or 35 hours per generator operating one generator at a time and up to 8 hours of integrated systems testing with up to five generators operating at one time. It is assumed that generators at EAT05 and EAT06-09 will undergo commissioning in the same 12-month period.
- **Stack Testing:** Ecology will require exhaust stack emission testing of two of 21 proposed generators at each data center (one 3.0-MWe engine and one 0.5-MWe engine for each data center) every 5 years in order to demonstrate continued compliance with air quality standards. It is assumed a stack test can take up to 16 hours of runtime.

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

1. For overall operations, including planned operations and operations during unplanned power outages:
    a. The cumulative runtime of EU-1 through EU-20 must be limited to 996 hours per any rolling 12-month period.
    b. The runtime of EU-21 must be limited to 65 hours per any rolling 12-month period.
    c. The cumulative runtime of EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through EU-105 must be limited to 5,024 hours per any rolling 12-month period.
    d. The cumulative runtime of EU-42, EU-63, and EU-84 must be limited to 234 hours per any rolling 12-month period.
    e. The cumulative runtime of EU-97 and EU-106 must be limited to 140 hours per any rolling 12-month period.
2. For planned operations of the permitted generators (EAT02):
    a. The cumulative runtime of EU-1 through EU-20 must be limited to 636 hours per any rolling 12-month period.
    b. The runtime of EU-21 must be limited to 60 hours per any rolling 12-month period.

   c. EU-1 through EU-20 must each be limited to no more than 9 hours of concurrent operation with any other engine per rolling 60-month period, except as allowed under Condition 2.d.

   d. Concurrent operations must be limited to the following:

      i. operation of no more than five engines: four engines amongst EU-1 through EU-20, along with EU-21, or

      ii. Operation of one engine amongst EU-1 through EU-21 and commissioning of one engine at another building.

3. For planned operations of the proposed generators (EAT03-04-05, EAT06-09):

   a. The cumulative runtime of EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through EU-105 must be limited to 3,584 hours per any rolling 12-month period, except as allowed under Condition 3.f.

   b. The cumulative runtime of EU-42, EU-63, and EU-84 must be limited to 180 hours per any rolling 12-month period, except as allowed under Condition 3.f.

   c. The cumulative runtime of EU-97 and EU-106 must be limited to 104 hours per any rolling 12-month period, except as allowed under Condition 3.f.

   d. EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through EU-105 must each be limited to no more than 24 hours of concurrent operation with any other engine per rolling 60-month period, except as allowed under Condition 3.e.

   e. Concurrent operations must be limited to the following:

      i. Operation of no more than five engines: Four engines amongst EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through EU-105, along with one engine from EU-42, EU-63, EU-84, EU-97, or EU-106.

      ii. Operation of one engine amongst EU-22 through EU-106 and commissioning of one engine at a different building.

   f. On a one-time basis each for EAT03, EAT04, EAT05, and EAT06-09 (four times total), for the construction and commissioning of the gensets:

      i. EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through UE-105 may operate an additional 1,092 hours, cumulative per commissioned building.

      ii. EU-42, EU-63, EU-84, EU-97, and EU-106 may operate an additional 52 hours per generator.

      iii. EU-22 through EU-41, EU-43 through EU-62, EU-64 through EU-83, EU-85 through EU-96, and EU-98 through EU-105 must each be limited to no more than an average of 8 hours per generator of concurrent operation with any other engine during commissioning.

4. For permitted and proposed generators (EAT02, EAT03-04-05, EAT06-09), operation of more than four 3.0-MWe generators and one 500-kWe generator concurrently must be limited to unplanned utility outages.

5. For permitted and proposed generators, non-emergency generator operation must be limited to between 7:00 a.m. and 7:00 p.m. local time.
6. For permitted and proposed generators, concurrent operation of generators occurs when two or more generators operate at the same moment. Generators are considered to operate concurrently even on occasions when the operational overlap occurs for just a short period of time (e.g., 1 minute or less). Sequential operation of generators is not considered concurrent operation even if multiple generators operate in the same minute, hour, or day.

3.3 Compliance with State and Federal Regulations

The Facility will comply with the following applicable air regulations, in accordance with the federal and state Clean Air Acts. These requirements are specified in:

- Chapter 70.94 Revised Code of Washington (RCW) (Washington Clean Air Act)
- Chapter 173-400 WAC (General Regulations for Air Pollution Sources)
- Chapter 173-460 WAC (Controls for New Sources of Toxic Air Pollutants; updated November 22, 2019)
- 40 CFR Part 60 Subpart A (General Provisions)
- 40 CFR Part 60 Subpart IIII (Stationary Compression Ignition Internal Combustion Engines)
- 40 CFR Part 63 Subpart ZZZZ (National Emission Standards for Hazardous Air Pollutants [NESHAP] for Reciprocating Internal Combustion Engines [RICEs]).

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

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

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

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

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

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

4.0 AIR POLLUTION EMISSION ESTIMATES

(Section VIII of NOC application form)

Air pollutant emission rates were calculated for the generators per the requirements of WAC 173-400-103 and WAC 173-460-050. Emission rates were calculated for criteria pollutants and TAPs based on peak hourly (worst-case maximum) and long-term (annual maximum) operating scenarios.

Manufacturer-reported potential site variation generator emission factors for CO, NO_X, and PM were used to estimate emission rates. Additionally, the manufacturer-reported potential site variation HC emission rate was assumed to represent the emission rate for total VOC emissions.

4.1 Generator Calculation Method

During any event for which the proposed emergency generators will supply power to the server system, the generators will operate at the load needed based on the electrical demand of the server system. Equipment and operating details used to calculate emission estimates are provided in Table 1. Microsoft is requesting flexibility to operate the generators at any load during maintenance and readiness testing events, consistent with the current permit for EAT02 (Approval Order No. 21AQ-C255 First Revision). Vendor-provided maximum emission rates for each pollutant are provided in Table 2 and are used for calculating the Facility potential-to-emit.

Emissions of DEEP were conservatively assumed to be equal to the manufacturers' not-to-exceed emissions value for PM emission rates.[2] The emission rates for PM with aerodynamic diameters of less than or equal to 10 microns (PM_{10}) and less than or equal to 2.5 microns ($PM_{2.5}$) include an estimate for "front-half" (filterable PM) and "back-half" (condensable PM) emissions. The filterable PM estimate is equal to the manufacturers' not-to-exceed emission factor for PM. An estimate of condensable PM was assumed to be equal to the manufacturers' not-to-exceed emission factor for HC.

All remaining pollutant emission rates, except for SO_2, were calculated using emission factors from the following sources, which provide emission factors for HAPs from large internal combustion diesel engines:

- EPA's AP-42, Volume I, Chapter 3.4 (EPA 1996)
- CATEF database (CARB; accessed February 2, 2023)
- VCAPCD AB 2588 (VCAPCD 2001).

These factors are based on maximum fuel consumption (ULSD or HVO). As listed in the generator specification sheets (provided in Appendix A), fuel consumption is highest at 100 percent load. Therefore, the maximum fuel consumption for full-variable load operations of all 22 proposed generators would be 301,513 gallons of diesel fuel per year. All proposed 20 3.0-MWe generators and two 500-kWe generators are to be equipped with cDPFs and SCR. For all of those engines, control

[2] The DEEP emission rate for the EAT02 3.0-MWe generators at 10 percent load was increased to account for the results of stack testing completed at the EAT02 Data Center on August 24-25, 2022.

efficiencies were applied to VOCs (50 percent) and PM/metals (85 percent) based on vendor-provided ecoCUBE control efficiency information.

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

Table 3 summarizes the maximum fuel-based project-only emission estimates and fuel consumption rates.

4.1.1 Startup Emissions

To account for slightly higher emissions during the first minute of each engine startup, the estimated emission rates of pollutants associated with startup (PM, CO, total VOCs, and volatile TAPs) were scaled up using a “black-puff” emission factor. These “black-puff” factors are based on short-term concentration trends for VOC and CO emissions observed immediately after startup of a large diesel backup generator. These observations were documented by the California Energy Commission’s report “Air Quality Implications of Backup Generators in California” (Lents et al. 2005). Landau’s derivation of startup emission factors is provided in Table 4. Additional details are provided in Appendix C. Note, emission rates used for modeling are described in greater detail in Section 7 and summarized in Appendix D.

Because an SCR must reach activation temperature before effectively controlling NO_X, modeling was conducted based on the very conservative assumption that there was no NO_X emission reduction for the first 20 minutes after a cold start when operating the proposed 3.0-MWe generators at 25 percent load and above. For the purposes of potential-to-emit calculations, it was assumed that there was no NO_X reduction for the first 15 minutes after a cold start when operating the proposed 3.0-MWe generators at 50 percent load and above; based on tests conducted by the SCR vendor, it was determined that this was a reasonable and conservative assumption that is likely to overestimate potential-to-emit. A more realistic (i.e., less conservative) warm-up period of 15 minutes was used for the potential-to-emit calculations to avoid unnecessarily triggering the requirement for a federal Title V Air Operating Permit by assuming operation at a generator load that Microsoft does not plan to run at for routine maintenance purposes. No control efficiency for NO_X was applied to the 10 percent load case. The SCR manufacturer provided a guaranteed ammonia emission rate of less than 10 ppm by volume dry at 15 percent oxygen at all loads.

The resultant Facility-wide potentials-to-emit are provided in Table 5. Table 6 shows the estimated project emission rates for each TAP expected to be released from the Facility’s emergency generator exhaust, and compares those emission rates to the corresponding small-quantity emission rates (SQERs; discussed further in Section 7.1.7).

4.2 Diesel Storage Tanks

The maximum fuel usage across the proposed 22 generators is 301,513 gallons per year (ULSD or HVO). Based on the low vapor pressure of diesel fuel and HVO (<0.01 pounds per square inch, atmosphere), the VOC emissions from the diesel storage tanks are expected to be minimal (i.e., less than 1 ton per year). Diesel and HVO can contain trace amounts of HAPs, which are expected to be a small fraction of the VOC emissions. Therefore, emissions of VOCs and HAPs from working and standing losses from the diesel or HVO storage tanks are not quantified.

5.0 EMISSION STANDARD COMPLIANCE

(Section VII of NOC application form)

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

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

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

6.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

(Section VIII of NOC application form)

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

6.1 General Approach for Best Available Control Technology Assessment

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

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

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

Based on a discussion with Ecology (Microsoft 2022), the economic evaluations conducted as part of the BACT analyses for Microsoft’s EAT02 (Landau 2021) and MWH (Landau 2019) data centers are considered representative for this proposed project. Therefore, Ecology has stated that use of Tier 2-certified generators is considered presumptive BACT for this project. The following is a summary of previously conducted BACT analyses on which this determination is based.

6.2 Steps 1, 2, and 3: Identify Feasible Control Technologies for Emergency Generators

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

- **Tier 4 integrated control package:** This control option consists of an integrated diesel particulate filter (DPF), diesel oxidation catalyst (DOC), and urea-based selective catalytic reduction (SCR). This system is highly efficient for control of NO_X (90 percent), $PM_{10}/PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (80 percent), and meets Tier 4 emission standards as defined by the federal regulations (40 CFR Part 89). Note, when engine or emission control system manufacturers are producing Tier 4-compliant engines, they will typically weld the DOC to the DPF and call it a "catalyzed DPF." While the Tier 4 integrated control package is technically feasible, it does have some operational constraints for emergency generators. For example, SCR typically does not provide NO_X removal when the engine exhaust temperature is below the target temperature of 500°F, which may occur at low loads.
- **Urea-based SCR:** This control option is highly efficient for control of NO_X (90 percent) and NO_2. While the SCR is technically feasible, it does have some operational constraints for emergency generators as described above.
- **Catalyzed DPF (DPF):** This control option is highly efficient for control of $PM_{10}/PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), and VOCs and gaseous TAPs (70 percent). The amount of condensable ("back-half") particulates removed by DPFs (if any) is not well understood.
- **Diesel oxidation catalyst:** This control option is highly efficient for removal of CO (70 percent), and VOCs and gaseous TAPs (70 percent). It is marginally effective for removal of $PM_{10}/PM_{2.5}$/DEEP (15 to 25 percent depending on the load). This analysis conservatively assumed 25 percent removal of $PM_{10}/PM_{2.5}$/DEEP ("front-half") for the DOC system.
- **Tier 2-certified engines:** Tier 2-certified engines rely on combustion controls and the use of ULSD fuel (15 ppm sulfur content) to comply with EPA Tier 2 emission standards.

6.3 Step 4: Evaluate Technically Feasible Technologies for Diesel Generators

All of the technologies listed above are assumed to be commercially available, reasonably reliable, and safe for use on backup diesel generators. Although all of the add-on control technology options associated with Tier 4 diesel engine controls (Tier 4 integrated control package, SCR, active or passive cDPF, or DOC) are technically feasible, each of them failed the BACT and tBACT cost-effectiveness evaluations (Landau 2019, 2021). Therefore, none of the add-on controls are BACT or tBACT because the costs of emission control are disproportionate to the benefit received. Instead, emission limitations consistent with the EPA's Tier 2 emission standards—achieved with combustion controls and the use of ULSD fuel or renewable diesel fuel—have been determined by Ecology to be presumptive BACT and tBACT. This determination is based on compliance with the EPA's Tier 2 emission standards for a nonroad diesel engine: 0.20 grams per mechanical kilowatt-hour (g/kWm hr) for PM, 3.5 g/kWm-hr for

CO, and 6.4 g/kWm-hr for combined NO_X plus VOCs. Proposed tBACT for SO_2 is use of ULSD fuel and/or renewable diesel fuel with a sulfur content not exceeding 15 ppm.

Microsoft's BACT and tBACT proposal is summarized in Table 7.

Microsoft is proposing to voluntarily install catalyzed DPFs and SCR on all generators at the EAT06-09 Data Center buildings.

7.0 AMBIENT AIR QUALITY IMPACT ANALYSIS

(Section IX of NOC application form)

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

As discussed in the following subsections, the modeled ambient impacts expected from project emissions are either less than the significant impact levels (SILs) or less than the NAAQS and WAAQS, even after summing with modeled local and regional background concentrations. With the exception of two TAPs (DEEP and NO_2), all predicted ambient TAP impacts are less than the ASILs. Therefore, a second-tier health impact assessment was conducted for DEEP and NO_2 and is being submitted under separate cover.

7.1 Modeling Methodology and Assumptions

Air dispersion modeling was conducted using the American Meteorological Society/EPA regulatory model (AERMOD) modeling system in general accordance with the EPA's 40 CFR Appendix W Final Rule (EPA 2017).

Ambient air impacts were modeled for all criteria pollutants and TAPs for which compliance was not demonstrated via emissions threshold screening. The most recent version of AERMOD (Version v22112) was used at the time the modeling was completed. AERMOD requires input from several preprocessors, described below, for meteorological parameters, downwash parameters, and terrain heights. AERMOD incorporates the data from the pre-processors with emission estimates and physical exhaust release point characteristics to predict ambient concentrations as a result of the proposed project. The model calculates concentrations based on various averaging times (e.g., 1 hour, 24 hours, annual, etc.) for a network of receptors and results are compared to air quality standards.

The AERMOD model was used to estimate the short-term impacts (i.e., 24-hour average or less) of PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ammonia, acrolein, hydrogen chloride, and mercury emissions and long-term impacts (i.e., annual average) of DEEP, PM_{10}, $PM_{2.5}$, NO_2, 1,3-butadiene, acetaldehyde, benzene, dibenz(a,h)anthracene, formaldehyde, naphthalene, arsenic, cadmium, and hexavalent chromium emissions.

7.1.1 Stack Parameters

Microsoft uses rain caps on generator exhaust stacks to prevent precipitation from entering the exhaust stacks. At low loads, the exhaust velocity is not great enough to entirely open the rain caps. This obstructs the flow of the exhaust, reducing the vertical velocity and increasing the plume width. According to a review conducted by Ecology, the exhaust exit velocity is reduced by 30 percent for a vertical stack with a rain cap that has an angle of 45 degrees (multiply the actual exhaust velocity by an adjustment factor of 0.7). At 10 percent generator operating load, a conservatively low exhaust exit velocity adjustment factor of 0.42 was used to calculate the adjusted velocity. At 25 percent load and greater, an exhaust exit velocity adjustment factor of 0.70 was used to calculate the adjusted velocity. The stack diameter was also adjusted to simulate the widening of the plume and to maintain the actual flow rate of the release. The effective stack diameter was calculated by dividing the actual flow by the adjusted exhaust velocity.

In addition to accounting for rain caps as described above, exhaust exit velocity and exhaust temperature were further adjusted to reflect the results of stack testing conducted at the EAT02 Data Center. The stack heights, stack diameters, effective stack diameters, adjustment percentages, and average adjusted velocity and temperature for the permitted and proposed generators for different load scenarios are provided in the table below.

Proposed 3.0-MWe Genset					
	Stack Height (ft)	Stack Diameter (in)	Avg. Adjusted Velocity (ft/min)	Temperature Adjustment Percent	Adjusted Temperature (°F)
	72	24			
Load	Effective Stack Diameter (ft)	Velocity Adjustment Percent			
10%	3.1	50%	373	30%	453
25%	2.4	50%	1,155	30%	578
50%	2.4	25%	2,812	25%	644
75%	2.4	25%	3,323	25%	649
100%	2.4	25%	4,231	25%	669

Proposed 0.5-MWe Genset					
	Stack Height (ft)	Stack Diameter (in)	Avg. Adjusted Velocity (ft/min)	Temperature Adjustment Percent	Adjusted Temperature (°F)
	30	10			
Load	Effective Stack Diameter (ft)	Velocity Adjustment Percent			
10%	1.3	50%	363	30%	379
25%	1.0	50%	845	30%	508
50%	1.0	25%	1,964	25%	667
75%	1.0	25%	3,068	25%	711
100%	1.0	25%	3,471	25%	741

Abbreviations and Acronyms:
°F = degrees Fahrenheit
ft = feet
ft/min = feet per minute
in = inches

Because stack exhaust temperature and velocity impact dispersion of pollutants, a screening analysis was completed to determine the operating load that results in the worst-case concentration for each pollutant and averaging period modeled. In the screening analysis, the exhaust temperature and exit velocity for each load case were modeled using a 1-pound-per-hour emission rate to generate a dispersion factor for each load and averaging period. The load-specific concentration for each pollutant was calculated by multiplying the dispersion factor with the emission rate for that load case. The results of the screening analysis are provided in Table 8.

The stack heights, stack diameters, effective stack diameters, adjustment percentages, and average adjusted velocity and temperature for the proposed nonroad generators are provided in the table below.

Proposed Nonroad 2.0-MWe Genset					
	Stack Height (ft)	Stack Diameter (in)			
	13.39	12			
Load	Effective Stack Diameter (ft)	Velocity Adjustment Percent	Avg. Adjusted Velocity (ft/min)	Temperature Adjustment Percent	Adjusted Temperature (°F)
10%	1.5	50%	1,249	30%	369
25%	1.2	50%	2,908	30%	489
50%	1.2	25%	6,332	25%	621
75%	1.2	25%	8,258	25%	662
100%	1.2	25%	10,077	25%	684

Proposed Nonroad 1.0-MWe Genset (1.0-MWe composed of two 0.5-MWe engines)					
	Stack Height (ft)	Stack Diameter (in)			
	12	5			
Load	Effective Stack Diameter (ft)	Velocity Adjustment Percent	Avg. Adjusted Velocity (ft/min)	Temperature Adjustment Percent	Adjusted Temperature (°F)
10%	0.64	50%	1,755	30%	320
25%	0.50	50%	3,476	30%	386
50%	0.50	25%	6,938	25%	495
75%	0.50	25%	8,301	25%	558
100%	0.50	25%	9,492	25%	628

7.1.2 Building Downwash

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

GEP stack height is defined as the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack plus 1.5 times the lesser dimension, height, or projected width of the nearby structure(s). The height of each of the two proposed data center buildings will be 28 feet. The generator stacks will be located along each side of the data center buildings.

7.1.3 Receptor Grid

To model complex terrain, AERMOD requires information about the surrounding terrain. The AMS/EPA regulatory model terrain pre-processor (AERMAP, version 18081) was used to obtain the hill height scale and the base elevation for each receptor location. The area inside the fence was regraded by Douglas County Permit No. FAR-2020-05. Therefore, elevations for the buildings, sources, and fenceline points were obtained from Microsoft's site diagrams instead of National Elevation Dataset (NED) data. AERMAP was used to determine the hill height scale for the fenceline receptor locations except where the hill height scale was equal to the elevation, then the elevation from site diagrams was used for the hill height scale. The regrading will not affect any elevations beyond the fenceline.

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

- 12.5-m spacing from the property boundary to 150 m
- 25-m spacing from 150 m to 400 m
- 50-m spacing from 400 m to 900 m
- 100-m spacing from 900 m to 2,000 m
- 300-m spacing from 2,000 m to 4,500 m
- 600-m spacing from 4,500 m to 10,000 m.

AERMAP requires the use of topographic data to estimate surface elevations above mean sea level. Digital topographic data (in the form of NED files) for the analysis region were obtained from the US Geological Survey National Map website (USGS; accessed November 22, 2023) and processed for use in AERMOD. The NED data used for this project have a resolution of approximately 10 m (⅓ arc-second).

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

7.1.4 Meteorology

AERMET (Version 22112) is the meteorological pre-processor model that estimates boundary-layer parameters for use in AERMOD. AERMET processes formatted meteorological data from observation stations and generates two input files for the AERMOD model: the Surface File with hourly boundary-layer parameter estimates; and the Profile File with multi-level observations of wind speed, wind direction, temperature, and standard deviations of fluctuating wind components. The meteorological observation data processed by AERMET for this project are described below.

- National Weather Service (NWS) hourly surface observations from Pangborn Memorial Airport in Douglas County, Washington located approximately ⅔ mile from the Facility. Five years (January 1, 2018 through December 31, 2022) of hourly surface data were processed in AERMET. AERMINUTE was run to reduce the instance of "calms." A potential concern related to the use of meteorological data for dispersion modeling is the high incidence of "calms," or periods of time with low wind speeds. NWS and Federal Aviation Administration data coding defines a wind speed of less than 3 knots as "calm" and assigns a value of 0 knots. This results in an overestimation of the amount of calm conditions. Similarly, if wind speed is up to 6 knots, but wind direction varies more than 60 degrees during a 2-minute averaging period, wind direction is reported as "missing." AERMINUTE reprocesses Automated Surface Observation System 1-minute wind data at a lower threshold and calculates hourly average wind speed and directions to supplement the standard hourly data processed in AERMET.
- NWS twice-daily upper air soundings from Spokane, Washington. Five years (January 1, 2018 through December 31, 2022) of upper air data were processed in AERMET.

Surface characteristics of albedo, Bowen ratio, and surface roughness are used by AERMET in stage 3 of the processing. Albedo is a measure of the solar radiation reflected back from earth into space. The Bowen ratio is an evaporation-related measurement and is defined as the ratio of sensible heat to latent heat. The surface roughness length is the theoretical height above ground where the wind speed becomes zero.

AERSURFACE version 20060 was used to determine the albedo, Bowen ratio, and surface roughness based on land-use/land-cover data from the 2019 National Land Cover Database (USGS 2016). AERSURFACE calculates the percentage of land-use type within each of 12 equal sectors of a circle centered on the surface station tower. The default study radii of 1 kilometer (km) for surface roughness and 10 km for the Bowen ratio and albedo were used. Default months were assigned in AERSURFACE to represent the four seasonal categories as follows: 1) mid-summer with lush vegetation; 2) autumn with unharvested cropland; 3) winter months with continuous snow; and 4) transitional spring with partial green coverage or short annuals. Winter months with continuous snow were determined by calculating the percentage of hours with snow depth greater than 0 inches. If a month had greater than 50 percent snow cover, it was assigned as a winter month with continuous snow. The AERSURFACE designation for an airport location (with the assumed surface roughness calculated based on 95 percent transportation and 5 percent commercial and industrial) is appropriate for this site in sectors 8 to 12.

Annual precipitation for Wenatchee for each modeled year was obtained from the Western Regional Climate Center database (WRCC; accessed November 22, 2023). The annual precipitation was within the top 30th percentile of the past 30 years of annual precipitation totals for 2022. Therefore, in accordance with EPA guidance, surface moisture conditions are considered wet when compared to historical norms and Bowen ratio values for wet surface moisture were used for that year. The annual precipitation was between the top and bottom 30th percentile of the past 30 years of annual precipitation totals for 2018 and 2019 so the Bowen ratio values for average surface moisture were used for those 2 years. The annual precipitation was within the bottom 30th percentile of the past 30 years of annual precipitation totals for 2020 and 2021 so the Bowen ratio values for dry surface moisture were used for those 2 years.

7.1.5 NO_X to NO_2 Conversion

The ambient NO_2 concentrations were calculated using the Plume Volume Molar Ratio Method (PVMRM) option within AERMOD, as described in the Air Dispersion Modeling Protocol submitted on October 30, 2023, and approved by Ecology (Landau 2023; Palcisko 2023). This AERMOD option calculates the amount of NO_X that is converted to NO_2 in the ambient air using a user-specified NO_2/NO_X equilibrium ratio, NO_2/NO_X in-stack ratio, and ambient ozone concentration. The PVMRM parameters were set as follows:

- Default NO_2/NO_X equilibrium ratio of 0.90
- NO_2/NO_X in-stack ratio of 0.1.[3]

Ambient ozone (O_3) was obtained from the "Kennewick-S Clodfelter Rd" and "Seattle-Beacon Hill" monitoring stations for the modeling period (2017 to 2021; Ecology; accessed September 11, 2023). The Kennewick station monitors O_3 seasonally (May to September) and the Seattle station provides year-round ambient O_3 concentrations. The O_3 PVMRM values from NWAIRQUEST's hybrid modeling and monitoring data are 51 parts per billion (ppb) for Wenatchee and 54 ppb for Kennewick. Therefore, data from the Kennewick monitor are considered conservative for NO_X conversion calculations at the Facility site. Values that correspond with exceptional events, such as wildfires, were left in the data set downloaded from the Ecology website.

Missing hours were filled as follows:

- 1- to 2-hour gaps were filled with an average of the hours before and after the missing hours.
- 3- to 24-hour gaps were filled with the maximum of the same hour from the day before and day after.
- 25+ hour gaps were filled with data from the Seattle station and left blank if the Seattle station data were also missing.

The season-by-hour O_3 option was used for the background O_3 values in AERMOD. To mirror the calculations performed for the NWAIRQUEST PVMRM values, the 75th-percentile of each season-hour was calculated. The season-by-hour O_3 values are shown in the table below.

[3] Based on data in the EPA's In-Stack Ratio Database for diesel/kerosene-fired reciprocating internal combustion engines (https://www3.epa.gov/scram001/no2_isr_database.htm).

Season-by-Hour Ozone Values for PVMRM in ppb

Hour	Winter	Spring	Summer	Fall
1	29.5	35.6	34.1	27.7
2	30.2	35.3	32.8	27.8
3	29.9	34.0	32.1	26.6
4	30.1	33.6	30.6	26.1
5	30.0	32.5	27.9	24.1
6	28.4	31.8	26.4	22.8
7	26.9	31.8	28.6	22.1
8	24.2	33.4	31.9	23.1
9	24.2	35.5	36.5	24.4
10	25.6	37.9	40.3	27.5
11	27.8	40.5	45.5	31.4
12	29.5	42.5	49.9	34.1
13	30.2	44.2	52.4	36.0
14	30.9	45.3	53.4	37.1
15	30.9	46.3	53.9	37.7
16	30.9	46.4	54.6	38.2
17	29.4	46.3	53.6	37.2
18	28.8	45.4	52.2	34.5
19	28.1	42.8	48.3	29.8
20	28.3	39.3	41.9	29.1
21	28.7	37.5	38.3	28.8
22	29.6	37.3	37.2	28.1
23	29.6	36.7	35.2	27.6
24	30.1	35.9	33.9	27.2

7.1.6 Background Concentration

This evaluation includes background concentrations contributed by existing regional and local nearby sources and “hyperlocal background” values contributed by nearby point sources. Project coordinate-specific regional background concentrations were obtained from the Idaho Department of Environmental Quality website (IDEQ; accessed November 30, 2023) for:

- CO 8-hour average
- CO 1-hour average

- SO_2 3-hour average
- SO_2 1-hour average
- PM_{10} 24-hour average
- $PM_{2.5}$ annual average
- $PM_{2.5}$ 24-hour average
- NO_2 annual average
- NO_2 1-hour average.

Consistent with the approach described in the Air Dispersion Modeling Protocol submitted on October 30, 2023, and approved by Ecology (Landau 2023; Palcisko 2023), local background concentrations included emissions from generators at the EAT02, and EAT03-04-05 Data Centers and modeling data from the most recent permit application for the nearby APL Data Center. Modeled stack parameters for onsite background sources are summarized in Appendix D. The concentration at a receptor near the center of the proposed Facility from the APL Data center modeling output was added to the regional background concentration for the following pollutants:

- CO 8-hour average
- SO_2 1-hour average
- NO_2 annual average
- NO_2 1-hour average
- PM_{10} 24-hour average
- $PM_{2.5}$ 24-hour average
- $PM_{2.5}$ annual average.

Regional and local background concentrations were added to the model-predicted project concentrations to estimate the projected cumulative concentration for those pollutants and averaging periods with modeled concentrations above the SIL.

7.1.6.1 Background NO_2

Regional background concentrations for NO_2 were obtained from the “Quincy-3rd Avenue” monitoring station. This station monitored NO_2 from August 2017 to September 2018. In accordance with the EPA’s guidance document, the background NO_2 concentration input to AERMOD is represented by the 1st-highest hourly NO_2 concentration within each season. Values that correspond with exceptional events, such as wildfires, were left in the data set downloaded from the Ecology website. The season-by-hour NO_2 values are provided in the table below.

Season-by-Hour NO_2 Background Concentrations in ppb

Hour	Winter	Spring	Summer	Fall
1	9.4	11.4	13.9	12.1
2	9.3	10.8	11.3	11.1
3	9.8	10.5	11.3	10.3
4	11.5	13.6	16.7	12.0
5	10.2	17.6	22.0	20.5
6	13.9	23.2	22.0	21.4
7	17.8	30.3	24.2	22.3
8	23.4	21.0	21.7	22.5
9	23.3	24.9	15.1	28.0
10	20.8	9.2	12.8	18.2
11	18.8	9.1	7.4	10.8
12	16.4	8.0	6.1	8.3
13	11.3	5.6	5.3	8.4
14	10.6	4.6	5.5	7.6
15	11.5	6.2	6.5	11.5
16	17.9	4.6	6.1	12.7
17	21.3	6.6	5.5	15.4
18	18.4	8.9	7.7	16.2
19	19.0	15.4	11.6	16.5
20	16.3	15.6	11.5	16.9
21	12.9	15.3	8.1	12.7
22	15.7	12.9	8.5	21.7
23	15.3	11.1	10.4	11.4
24	11.9	11.5	12.9	12.1

7.1.7 First-Tier Screening of Toxic Air Pollutant Impacts

A first-tier TAP assessment compares the forecast emission rates to the SQERs and compares the maximum ambient concentrations to ASILs. Table 6 shows the estimated project emission rates for each TAP expected to be released in the EAT06-09 emergency generator exhaust and compares those emission rates to the corresponding SQER. Each SQER is an emission rate threshold, below which Ecology does not require an air quality impact assessment for the corresponding TAP. As shown in Table 6, estimated project-only emissions of NO_2, DEEP, ammonia, 1,3-butadiene, acetaldehyde, acrolein, benzene, dibenz(a,h)anthracene, formaldehyde, hydrogen chloride, naphthalene, arsenic, cadmium, hexavalent chromium, and mercury are greater than their respective SQERs, so an ambient impact analysis was completed for those TAPs.

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

7.1.8 Monte Carlo Statistical Analysis

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

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

7.2 Modeled Emission Rates

7.2.1 Annual Averaging Period

Annual potential-to-emit rates were established for the worst-case single-year scenario and modeled. This worst-case single-year scenario is a year in which all data centers (EAT02, EAT03, EAT04, EAT05, and EAT06-09) commence normal operations, stack testing, and emergency operations; and EAT05 and EAT06-09 are commissioned. However, the hours for preventive maintenance during normal operations for EAT05 and EAT06-09 were reduced to account for the portion of the year prior to commissioning when the generators are not yet operating.

The annual runtimes for each generator were assigned as follows:

- 50 hours for the permitted EAT02 3.0-MWe generators
- 65 hours for the permitted EAT02 500-kWe generators
- 63 hours for the proposed EAT03 3.0-MWe generators

- 78 hours for the proposed EAT03 500-kWe generators
- 39 hours for the proposed EAT04 3.0-MWe generators
- 54 hours for the proposed EAT04 500-kWe generators
- 83 hours for the proposed EAT05 3.0-MWe generators
- 98 hours for the proposed EAT05 500-kWe generators
- 71 hours for the proposed EAT06-09 3.0-MWe generators
- 78 hours for the proposed EAT06-09 500-kWe generators.

The total maximum year emission rate is divided by the number of hours in a year (8,760 hours) to establish the pounds per hour emission rate input into AERMOD. These emission assumptions were used for the following:

- $PM_{2.5}$ annual average
- NO_2 annual average
- TAPs annual average [i.e., DEEP, 1,3-butadiene, acetaldehyde, benzene, dibenz(a,h)anthracene, formaldehyde, naphthalene, arsenic, cadmium, and hexavalent chromium].

7.2.2 Short-Term Averaging Period

To determine the worst-case ambient impacts for short-term averages (i.e., 1-hour, 3-hour, and 8-hour), the modeling setup assumed all 22 generators would be concurrently operating for 24 hours per day, 365 days per year. These assumptions are to address the conservative consideration that a power outage could occur at any time of day or night on any day of the year. These emission assumptions were used for the following:

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

7.2.3 24-Hour Averaging Period

The $PM_{2.5}$ 24-hour average NAAQS is also a probabilistic standard based on the 98th percentile of the 24-hour average concentration (equivalent to the 8th-highest 24-hour concentration in 1 year) averaged over 3 years. Ecology allows compliance to be demonstrated with this standard by modeling the 8th-highest daily emissions and reporting the 1st-highest 24-hour average concentration. As shown in Table D-2 (Appendix D), the 8th-highest emitting day occurs during commissioning integrated system test operations when five engines operate at a time for up to 4 hours per day.

The PM_{10} 24-hour average NAAQS is not to be exceeded more than once per year on average over 3 years. Ecology allows for compliance with this standard to be determined by finding the 6th-highest concentration averaged over 5 years. The operating scenario modeled assumed that all 22 generators would be operating concurrently due to a 9-hour emergency power outage.

For TAPs with 24-hour averaging periods (acrolein, ammonia, hydrogen chloride, and mercury), the modeling setup assumed that all 22 generators would be operating concurrently for 9 hours per day, 365 days per year due to an emergency power outage.

7.3 Predicted Criteria Pollutant Ambient Concentrations

The results of the criteria pollutant modeling are provided in Tables 9 and 10. Emission rate estimates and stack parameters for these scenarios are provided in Appendices D and E.

The model-predicted ambient impacts for CO (1-hour and 8-hour average), SO_2 (3-hour average), and $PM_{2.5}$ (annual average) are less than the SIL. The model-predicted ambient impacts plus background for all other pollutants and averaging periods are less than the NAAQS.

7.3.1 NO_2 1-Hour Average Modeling and Statistical Analysis

For demonstration of project compliance with the NO_2 1-hour average NAAQS, each engine runtime scenario has been characterized based on worst-case potential project emissions and stack parameters, as shown in Appendix D. The operating days considered in the statistical analysis are provided in Table D-3 in Appendix D.

Each of the above-noted engine runtime scenarios was modeled using the PVMRM option. In accordance with Ecology's supplemental procedures provided in May 2021 (Dhammapala 2021), the once-in-5-year operations are modeled using 1 year of meteorological data and the "source groups not in all years" option. The year in which the highest-first-high occurred in the permitted generator UST/UPM model run is 2018 for EAT02-03-04, and 2019 for EAT05-06-09. Therefore, 2018 and 2019 were selected as the model run years. Background NO_2 concentrations were included in the model runs.

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

Based on the assumptions outlined above for the stochastic Monte Carlo analysis, the 3-year rolling average of the 98th-percentile of the project maximum daily 1-hour average concentration of NO_2 is predicted to occur at the northeast corner of the property boundary (as shown on Figure 3). As shown in Table 9, the estimated cumulative concentration at this maximum project impact location is 112 micrograms per cubic meter (μg/m^3), which is less than the NO_2 1-hour average NAAQS of 188 μg/m^3.

7.4 Predicted Toxic Air Pollutant Ambient Concentrations

The first-tier ambient concentration screening analysis is summarized in Table 10. This screening analysis was conducted on all TAPs with expected emission rates that exceed the SQER (as shown in Table 6). As shown in Table 10, the maximum modeled ambient concentrations for ammonia, 1,3-butadiene, acetaldehyde, acrolein, benzene, dibenz(a,h)anthracene, formaldehyde, hydrogen chloride, naphthalene, arsenic, cadmium, hexavalent chromium, and mercury are less than their respective ASILs.

7.4.1 1-Hour NO_2 Impacts During Facility-Wide Concurrent Generator Operation

The AERMOD model for this scenario was set up to assume that Microsoft would operate 22 generators for 24 hours per day, 365 days per year. The maximum modeled 1st-highest 1-hour average ambient NO_2 concentration was 758 µg/m^3 (Table 11), which exceeds the ASIL of 470 µg/m^3. The location of the modeled maximum ambient impact is shown on Figure 3.

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

7.5 Nonroad Generators

NAAQS modeling was conducted as described above, substituting one 2.0-MWe nonroad generator and one 1.0-Mwe nonroad generator for one 3.0-MWe regular generator, to simulate a scenario in which the nonroad generators would be employed. The nonroad generators were modeled at a location near the highest modeled property-line impacts. The model-predicted ambient impacts plus background for all pollutants and averaging periods are less than the NAAQS. Predicted pollutant concentrations compared to the NAAQS for the nonroad generators are shown in Table 12. An application form and vendor-provided specifications are provided in Appendix F.

8.0 USE OF THIS REPORT

This document has been prepared for the use of Microsoft and applicable regulatory agencies for specific application to the East Wenatchee Data Center Campus. The reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau, shall be at the user's sole risk. Landau warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. Landau makes no other warranty, either express or implied.

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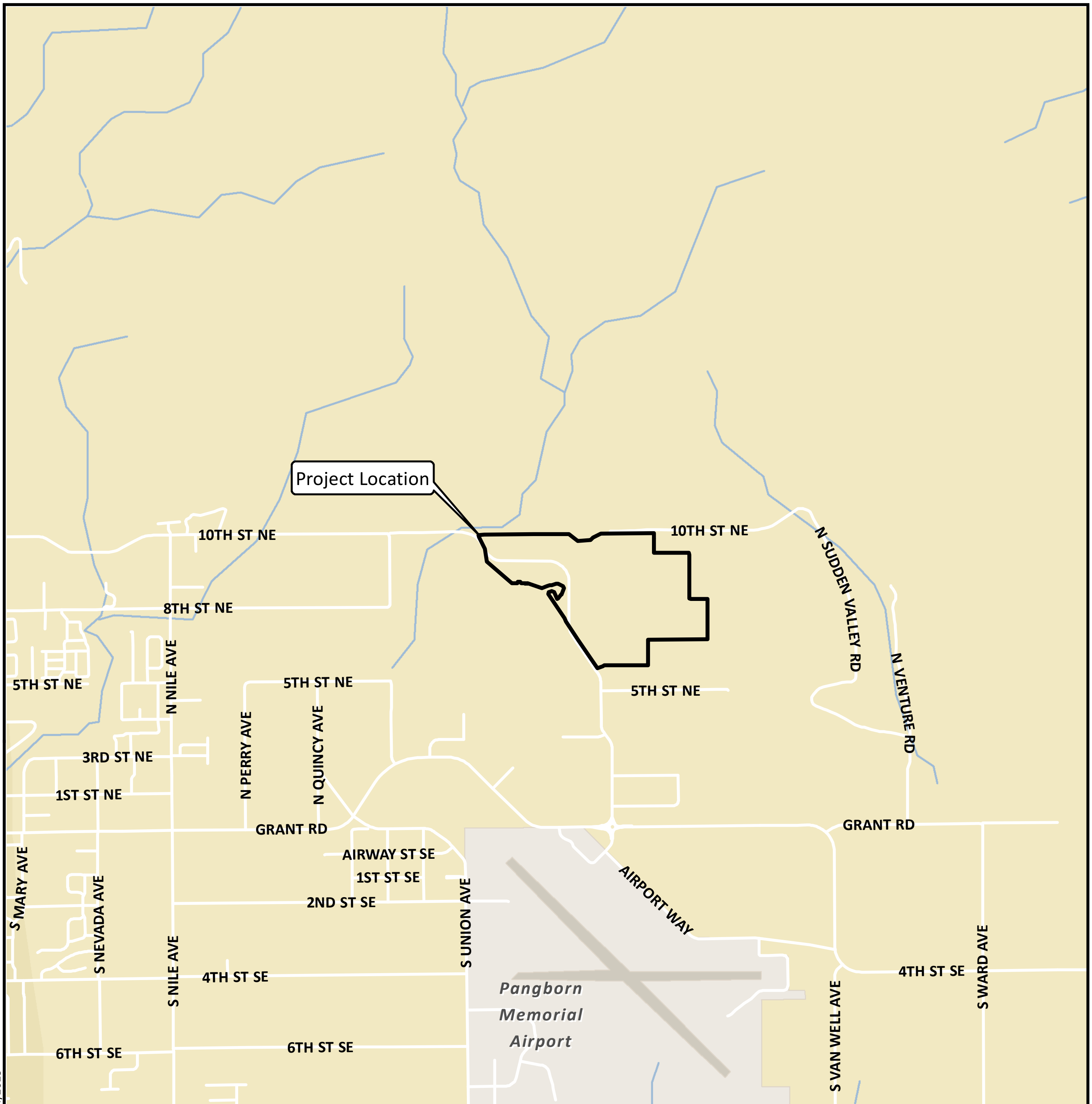

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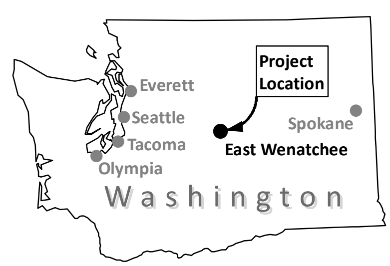

Data Sources: Douglas County GIS; Esri.

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Microsoft Corporation East Wenatchee Data Center Campus Douglas County, Washington	**Vicinity Map**	Figure 1

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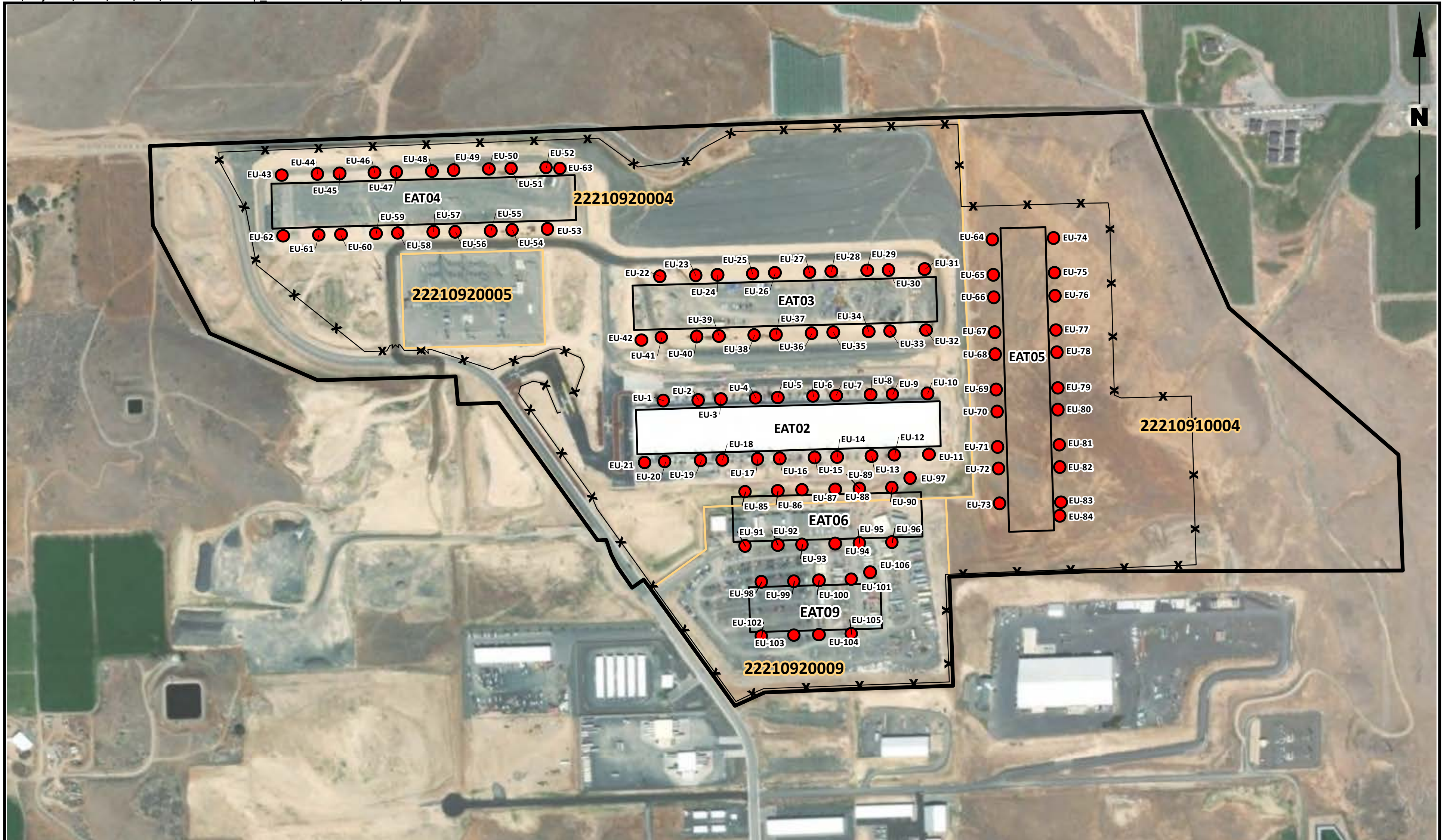

Legend

- Generator Stack Locations
- Fence Line
- Buildings
- Subject Property
- Parcels

0 600 1,200

Scale in Feet

Note

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

Data Sources: Douglas County GIS; Esri World Imagery.

LANDAU ASSOCIATES

Microsoft Corporation East Wenatchee Data Center Campus Douglas County, Washington	**Site Map**	Figure 2

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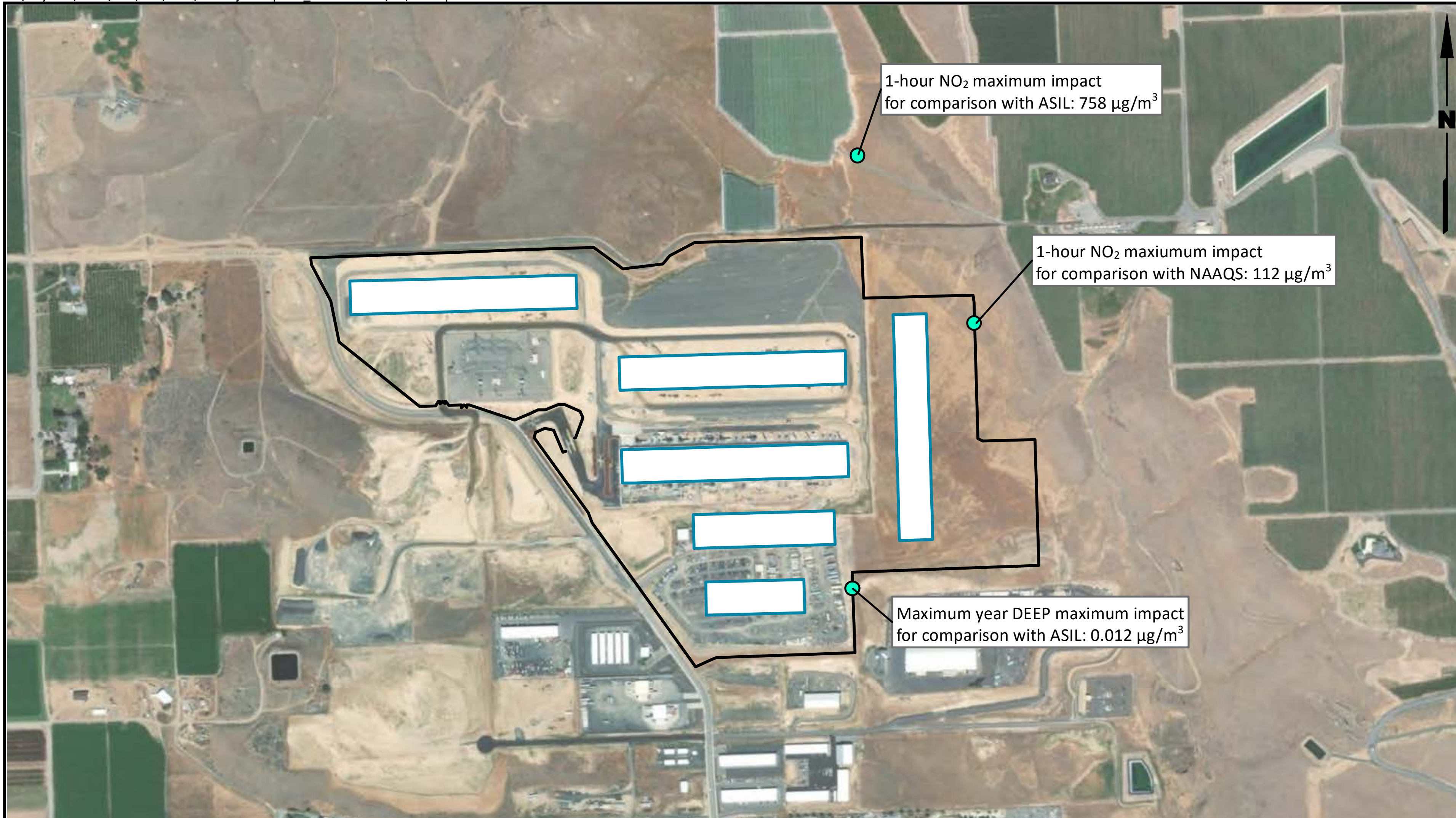

Legend

Fence Line

Buildings

Note
1. µg/m³ = micrograms per cubic meter
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 750 1,500

Scale in Feet

Data Sources: Douglas County GIS; Esri World Imagery.

LANDAU ASSOCIATES

Microsoft Corporation
East Wenatchee Data Center Campus
Douglas County, Washington

Project Impacts

Figure 3

Abbreviations and Acronyms
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

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

Table 1
Equipment Summary and Operating Rates
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Engine Parameter	Units		EAT02		EAT03		EAT04		EAT05	
			3.0 MW	0.5 MW	3.0 MW	0.5 MW	3.0 MW	0.5 MW	3.0 MW	0.5 MW
EPA Diesel Emission Tier	--		Tier 2	Tier 2	Tier 4	Tier 2	Tier 4	Tier 2	Tier 4	Tier 2
Generator Output	kW		3,000	500	3,000	500	3,000	500	3,000	500
Number of Gensets	gensets		20	1	20	1	20	1	20	1
Fuel Type	--		ULSD	ULSD	ULSD	ULSD	ULSD	ULSD	ULSD	ULSD
Fuel Usage per Genset	gal/hr	a	213.2	35.7	209	35.7	209	35.7	209	35.7
Worst-Case Scenario Maximum Daily Operating Hours per Genset	hrs/day	b	9	9	9	9	9	9	9	9
Worst-Case Scenario Maximum Annual Operating Hours per Genset	hrs/yr	c	50	65	63	78	39	54	83	98

Engine Parameter	Units		EAT06-09		Nonroad	
			3.0 MW	0.5 MW	2.0 MW	1.0 MW
EPA Diesel Emission Tier	--		Tier 4	Tier 4	Tier 4	Tier 4
Generator Output	kW		3,000	500	2,000	1,000
Number of Gensets	gensets		20	2	1	1
Fuel Type	--		ULSD	ULSD	ULSD	ULSD
Fuel Usage per Genset	gal/hr	a	209	35.7	126.2	73
Worst-Case Scenario Maximum Daily Operating Hours per Genset	hrs/day	b	9	9	9	9
Worst-Case Scenario Maximum Annual Operating Hours per Genset	hrs/yr	c	71	78	40	40

Notes:

[a] Maximum of generator at any load (≤100 percent load), ULSD or HVO, based on vendor specifications.

[b] Based on a potential 24-hr day period where all gensets of all buildings are running for emergency operations for 9 hours.

[c] Based on a potential 12-month period where all buildings are conducting emergency operations, preventive maintenance, and stack testing, plus EAT02 and EAT03 conducting additional quinquennial testing, and EAT05 and EAT06-09 conducting additional commissioning. For EAT05 and EAT06-09, the preventive maintenance is only partial of a full year to account for concurrent commissioning activities in the same year. For the nonroad engines, the scenario assumes emergency operations, preventive maintenance, and installation.

Table 2
Vendor-Reported Air Pollutant Emission Rates
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

	Worst-Case Emission Rates in lb/hr[a]							
	EAT02		EAT03-04-05		EAT06-09		Nonroad	
Pollutant	3.0 MW Tier 2	0.5 MW Tier 2	3.0 MW Tier 4[d]	0.5 MW Tier 2	3.0 MW Tier 4[d]	0.5 MW Tier 4[d]	2.0 MW Tier 4[d]	1.0 MW Tier 4[d,e]
NO_X	70.81	8.17	27.55	9.15	27.55	3.66	16.50	8.32
CO	7.61	2.18	1.61	2.18	1.61	0.44	0.70	0.02
HC	0.85	0.10	0.43	0.10	0.43	0.07	0.24	0.08
DEEP[b]	0.38	0.17	0.06	0.17	0.06	0.03	0.17	0.08
PM (FH+BH)[c]	1.15	0.24	0.48	0.24	0.48	0.08	0.39	0.16

Notes:

[a] Determined based on maximum vendor-reported emission rate for each pollutant at 10%, 25%, 50%, 75%, and 100% load.

[b] DEEP is assumed equal to front-half Potential Site Variation particulate emissions, as vendor-reported PM.

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

[d] NO_X reflects worst-case emission rate that includes 20 minutes of uncontrolled and 40 minutes of controlled.

[e] 1.0-MW nonroad generator is composed of two 0.5-MW engines in one housing. Emissions represent 0.5-MW emissions doubled.

Table 3
Fuel-Based Emissions Summary
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Combined Facility-Wide Usage	Units		Hourly	Daily[a]	Total Annual[b]
Fuel Usage	gal	c	21,198	190,784	1,295,184
Heat Input	MMBtu	d	2,904	26,137	177,440

Pollutant	CAS No./ ID	Uncontrolled Emission Factor			Facility-Wide PTE[e,f] Hourly (lb/hr)	Daily[a] (lb/day)	Annual[b] (tpy)
Toxic Air Pollutants (TAPs)							
SO_2	7446-09-5	0.0015%	sulfur (wt)	d	4.51	40.55	1.38E-01
Ammonia (slip)	7664-41-7	10	ppm	g	21.04	189.37	6.72E-01
1,3-Butadiene	106-99-0	1.59E-03	lb/MMBtu	h	2.93	25.20	8.49E-02
Acetaldehyde	75-07-0	5.72E-03	lb/MMBtu	h	10.57	90.78	3.06E-01
Acrolein	107-02-8	2.47E-04	lb/MMBtu	h	0.46	3.93	1.32E-02
Benzene	71-43-2	1.36E-03	lb/MMBtu	h	2.51	21.59	7.27E-02
Benz(a)anthracene	56-55-3	7.90E-06	lb/MMBtu	i	1.46E-02	1.25E-01	4.23E-04
Benzo(a)pyrene	50-32-8	6.43E-06	lb/MMBtu	i	1.19E-02	1.02E-01	3.44E-04
Benzo(b)fluoranthene	205-99-2	1.28E-05	lb/MMBtu	i	2.36E-02	2.03E-01	6.84E-04
Benzo(k)fluoranthene	207-08-9	1.26E-05	lb/MMBtu	i	2.32E-02	2.00E-01	6.72E-04
Chlorobenzene	108-90-7	1.46E-06	lb/MMBtu	h	2.70E-03	2.32E-02	7.81E-05
Chrysene	218-01-9	7.10E-06	lb/MMBtu	i	1.31E-02	1.13E-01	3.80E-04
Dibenz(a,h)anthracene	53-70-3	6.77E-06	lb/MMBtu	i	1.25E-02	1.08E-01	3.62E-04
Ethyl benzene	100-41-4	7.95E-05	lb/MMBtu	h	0.15	1.26	4.26E-03
Formaldehyde	50-00-0	1.26E-02	lb/MMBtu	h	23.30	200.04	6.74E-01
n-Hexane	110-54-3	1.96E-04	lb/MMBtu	h	0.36	3.12	1.05E-02
Hydrogen chloride	7647-01-0	1.36E-03	lb/MMBtu	h	2.51	21.59	7.27E-02
Indeno(1,2,3-cd)pyrene	193-39-5	6.71E-06	lb/MMBtu	i	1.24E-02	1.07E-01	3.59E-04
Naphthalene	91-20-3	2.60E-04	lb/MMBtu	i	0.48	4.14	1.39E-02
Propylene	115-07-1	3.41E-03	lb/MMBtu	h	6.30	54.12	1.82E-01
Toluene	108-88-3	7.69E-04	lb/MMBtu	h	1.42	12.22	4.12E-02
m-Xylene	108-38-3	1.58E-04	lb/MMBtu	i	0.29	2.50	8.43E-03
o-Xylene	95-47-6	1.52E-04	lb/MMBtu	i	0.28	2.42	8.16E-03
Xylenes	1330-20-7	3.09E-04	lb/MMBtu	h	0.57	4.91	1.66E-02
Metals [j]							
Arsenic	7440-38-2	1.17E-05	lb/MMBtu	h	1.17E-02	1.00E-01	3.15E-04
Cadmium	7440-43-9	1.09E-05	lb/MMBtu	h	1.10E-02	9.40E-02	2.95E-04
Copper	7440-50-8	2.99E-05	lb/MMBtu	h	2.99E-02	2.57E-01	8.07E-04
Hexavalent chromium	18540-29-9	7.30E-07	lb/MMBtu	h	7.30E-04	6.27E-03	1.97E-05
Lead	7439-92-1	6.06E-05	lb/MMBtu	h	6.06E-02	5.20E-01	1.63E-03
Manganese	7439-96-5	2.26E-05	lb/MMBtu	h	2.26E-02	1.94E-01	6.10E-04
Mercury	7439-97-6	1.46E-05	lb/MMBtu	h	1.46E-02	1.25E-01	3.94E-04
Nickel	7440-02-0	2.85E-05	lb/MMBtu	h	2.85E-02	2.45E-01	7.68E-04
Selenium	7782-49-2	1.61E-05	lb/MMBtu	h	1.61E-02	1.38E-01	4.33E-04
Total chromium	7440-47-3	4.38E-06	lb/MMBtu	h	4.38E-03	3.76E-02	1.18E-04
Zinc	7440-66-6	1.63E-04	lb/MMBtu	h	1.64E-01	1.40E+00	4.41E-03
Other Hazardous Air Pollutants (HAPs) [k]							
Acenaphthene	83-32-9	1.43E-05	lb/MMBtu	i	2.64E-02	2.27E-01	7.65E-04
Acenaphthylene	208-96-8	1.72E-05	lb/MMBtu	i	3.19E-02	2.74E-01	9.22E-04
Anthracene	120-12-7	9.69E-04	lb/MMBtu	i	1.79E+00	1.54E+01	5.18E-02
Benzaldehyde	100-52-7	9.22E-05	lb/MMBtu	i	1.71E-01	1.46E+00	4.93E-03
Benzo(g,h,i)perylene	191-24-2	6.84E-06	lb/MMBtu	i	1.26E-02	1.09E-01	3.66E-04
Fluoranthene	206-44-0	1.09E-05	lb/MMBtu	i	2.02E-02	1.73E-01	5.84E-04
Fluorene	86-73-7	5.21E-05	lb/MMBtu	i	9.64E-02	8.27E-01	2.79E-03
PAHs (including naphthalene)	PAH	4.08E-04	lb/MMBtu	h	7.54E-01	6.48E+00	2.18E-02
Phenanthrene	85-01-8	1.01E-04	lb/MMBtu	i	1.87E-01	1.61E+00	5.42E-03
Pyrene	129-00-0	1.80E-05	lb/MMBtu	i	3.33E-02	2.86E-01	9.63E-04

Notes:

[a] Based on a potential 24-hr day period where all gensets of all buildings are running for emergency operations for 9 hours.

[b] Based on a potential 12-month period where all buildings are conducting emergency operations, preventive maintenance, and stack testing, plus EAT02 and EAT03 conducting additional quinquennial testing, and EAT05 and EAT06-09 conducting additional commissioning. For EAT05 and EAT06-09, the preventive maintenance will occur only during part of the year as no operations would occur prior to or during commissioning of each building.

[c] Based on maximum fuel use at any load (≤100 percent load), ULSD or HVO, based on vendor specifications.

[d] Calculated assuming the following ULSD fuel parameters:

Heat Content =	137,000	Btu/gal
Sulfur Content =	15	ppmw
Density =	7.1	lb/gal

[e] For Tier 4 gensets, the final emission factor used is the uncontrolled emission factor multiplied by control efficiencies from the vendor-provided ecoCUBE control efficiency information (see Appendix A). All TAPs use the HC control efficiency, and all metals and other HAPs use the PM control efficiency.

HC (VOC) Reduction =	50%	(for loads ≥25% for all non-metal pollutants)
PM Reduction =	85%	(for all loads ≥10% for all metal pollutants)

Table 3
Fuel-Based Emissions Summary
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

[f] Assumes that in one cold-start hour, the first 1 minute is scaled to a cold-start factor (see Table 4), and the remaining 59 minutes is not scaled. No scaling is applied to regular run hours.

PM/HC Cold-Start Scaling Factor = 4.27

[g] Ammonia slip values of SCR on Tier 4 gensets only from vendor specifications (Caterpillar, Peter Powers). No cold-start scaling was applied to be conservative in emission estimates. Using an equation derived from the combined gas law, the vendor-provided actual gas flow was first converted to standard gas flow using vendor-provided temperature along with an assumed standard pressure at sea level. The calculated standard gas flow was then used to calculate total ammonia emissions.

$scfm = acfm \times (P_a/P_s) \times (T_s/T_a)$

where:
- scfm = gas flow (standard cubic feet per minute)
- acfm = gas flow (actual cubic feet per minute)
- P_a = actual gas pressure
- T_a = actual gas temperature
- P_s = standard gas pressure
- T_s = standard gas temperature

	3.0 MW	0.5 MW
Load (%) =	100	100
Actual Flow (acfm) =	25320.3	3605.5
Actual Pressure (psia) =	14.7	14.7
Actual Temp. (°F) =	892.4	987.8
Actual Temp. (°R) =	1352.4	1447.8
Standard Pressure (psia) =	14.7	14.7
Standard Temp. (°R) =	527.67	527.67
Standard Flow (scfm) =	**9,879**	**1,314**

NH_3 (lb/hr) = [NH3 Concentration (ppm)] × [Molecular Weight of NH_3 (lb/lb-mol)] × [(lb-mol/MMscf/hr)] × [Standard Gas Flow (scfm)]

where:
- molecular weight of NH_3 = 17.031 lb/lb-mol
- Conversion factor = 1.558E-07 lb-mol/MMscf/hr

[h] Source: Ventura County Air Pollution Control District AB 2588 Diesel Internal Combustion Factors.

[i] Source: California Air Toxics Emission Factor (CATEF) database for ICE, Diesel engines; takes average of mean; converted from lb/Mgal to lb/MMBtu using heat content of 19,300 Btu/lb and density of 7.1 lb/gal.

[j] Green shading indicates metals.

[k] Blue shading indicates HAPs that are not TAPs listed in WAC 460 12-23-2019.

Table 4
Vendor-Reported Emissions with Startup
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

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

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

Cold-Start Hour (Single Hour) Emissions[a]

	EAT02						EAT03-04-05					
	3.0 MW Tier 2			0.5 MW Tier 2			3.0 MW Tier 4			0.5 MW Tier 2		
Pollutant	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)
NO_X[b]	1.2	70	**71**	0.14	8.0	**8.2**	18	4.73	**22**	0.15	9.0	**9.2**
CO	1.1	7.5	**8.6**	0.33	2.1	**2.5**	0.24	1.6	**1.8**	0.33	2.1	**2.5**
HC	0.060	0.84	**0.90**	0.0071	0.10	**0.11**	0.031	0.43	**0.46**	0.0071	0.10	**0.11**
DEEP	0.027	0.37	**0.40**	0.012	0.17	**0.18**	0.0041	0.057	**0.061**	0.012	0.17	**0.18**
PM (FH+BH)	0.082	1.1	**1.2**	0.017	0.24	**0.25**	0.034	0.47	**0.50**	0.017	0.24	**0.25**

	EAT06-09						Nonroad					
	3.0 MW Tier 4			0.5 MW Tier 4			2.0 MW Tier 4			1.0 MW Tier 4		
Pollutant	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)	Startup (lb/1 min)	Warm (lb/59 min)	Total Hour (lb/hr)
NO_X[b]	18	4.7	**22**	2.3	0.69	**3.0**	10.61	2.6	**13.25**	5.73	0.8	**6.50**
CO	0.24	1.6	**1.8**	0.065	0.43	**0.49**	0.105	0.688	**0.79**	0.003	0.019	**0.022**
HC	0.031	0.43	**0.46**	0.0051	0.071	**0.076**	0.017	0.236	**0.25**	0.006	0.079	**0.084**
DEEP	0.0041	0.057	**0.061**	0.0018	0.025	**0.027**	0.012	0.167	**0.18**	0.006	0.079	**0.084**
PM (FH+BH)	0.034	0.47	**0.50**	0.0059	0.081	**0.087**	0.028	0.384	**0.41**	0.011	0.157	**0.17**

Worst-Case Single Year Potential-To-Emit per Genset[c]

	EAT02		EAT03		EAT04		EAT05		EAT06 & EAT09		Nonroad	
Pollutant	Tier 2 (lb/yr)	Tier 2 (lb/yr)	Tier 4 (lb/yr)	Tier 2 (lb/yr)	Tier 4 (lb/yr)	Tier 2 (lb/yr)	Tier 4 (lb/yr)	Tier 2 (lb/yr)	Tier 4 (lb/yr)	Tier 4 (lb/yr)	Tier 4 (lb/yr)	Tier 4 (lb/yr)
NO_X[b]	3,526	531	1,628	714	993	494	1,951	897	1,663	247	608	304
CO	399	149	105	177	66	123	147	233	126	37	29	1
HC	43	7	28	8	17	5	37	10	32	6	10	3
DEEP	19	11	4	13	2	9	5	17	4	2	7	3
PM (FH+BH)	59	16	30	19	19	13	41	24	35	7	16	7

Table 4
Vendor-Reported Emissions with Startup
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Notes:

[a] Startup emission factor, which is the worst-case emission rate multiplied by the cold-start scaling factor, applies to the first 60 seconds of emissions after engine startup.

[b] Although the cold-start scaling factor for NO_X is less than 1 (i.e., decreased emissions), this evaluation conservatively assumes a factor of 1.0. For Tier 4 generators, a SCR warm-up period of 15 minutes was applied to NO_X emissions at 50% to 100% load, thus the units for Tier 4 NO_X Startup is (lb/15 min) and for Warm is (lb/45 min).

[c] Annual emissions are based on a potential 12-month period with all buildings conducting emergency operations, preventive maintenance, and stack testing, plus EAT02, EAT03, and EAT04 conducting additional quinquennial testing, and EAT05 and EAT06-09 conducting additional commissioning.

Table 5
Potential-to-Emit Emissions Summary
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	CAS No./ID	Facility-Wide PTE Hourly[a] (lb/hr)	Facility-Wide PTE Annual[b] (tpy)
Criteria Pollutants			
NO_X	NOX [c]	3,237	99.18
CO	630-08-0	329	9
VOC	VOC	55	1.6
SO_2	7446-09-5	4.5	0.14
$PM_{10}/PM_{2.5}$	PM	66	1.9
Toxic Air Pollutants (TAPs)			
Primary NO_2	10102-44-0 [c]	324	9.9
DEEP	DEEP	14	0.37
CO	630-08-0	329	9
SO_2	7446-09-5	4.51E+00	1.38E-01
Ammonia	7664-41-7	2.10E+01	6.72E-01
1,3-Butadiene	106-99-0	2.93E+00	8.49E-02
Acetaldehyde	75-07-0	1.06E+01	3.06E-01
Acrolein	107-02-8	4.58E-01	1.32E-02
Benzene	71-43-2	2.51E+00	7.27E-02
Benz(a)anthracene	56-55-3	1.46E-02	4.23E-04
Benzo(a)pyrene	50-32-8	1.19E-02	3.44E-04
Benzo(b)fluoranthene	205-99-2	2.36E-02	6.84E-04
Benzo(k)fluoranthene	207-08-9	2.32E-02	6.72E-04
Chlorobenzene	108-90-7	2.70E-03	7.81E-05
Chrysene	218-01-9	1.31E-02	3.80E-04
Dibenz(a,h)anthracene	53-70-3	1.25E-02	3.62E-04
Ethylbenzene	100-41-4	1.47E-01	4.26E-03
Formaldehyde	50-00-0	2.33E+01	6.74E-01
n-Hexane	110-54-3	3.63E-01	1.05E-02
Hydrogen chloride	7647-01-0	2.51E+00	7.27E-02
Indeno(1,2,3-cd)pyrene	193-39-5	1.24E-02	3.59E-04
Naphthalene	91-20-3	4.82E-01	1.39E-02
Propylene	115-07-1	6.30E+00	1.82E-01
Toluene	108-88-3	1.42E+00	4.12E-02
m-Xylene	108-38-3	2.91E-01	8.43E-03
o-Xylene	95-47-6	2.82E-01	8.16E-03
Xylenes	1330-20-7	5.72E-01	1.66E-02

Table 5
Potential-to-Emit Emissions Summary
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	CAS No./ID	Facility-Wide PTE Hourly[a] (lb/hr)	Facility-Wide PTE Annual[b] (tpy)
Metals			
Arsenic	7440-38-2	1.17E-02	3.15E-04
Cadmium	7440-43-9	1.10E-02	2.95E-04
Copper	7440-50-8	2.99E-02	8.07E-04
Hexavalent chromium	18540-29-9	7.30E-04	1.97E-05
Lead	7439-92-1	6.06E-02	1.63E-03
Manganese	7439-96-5	2.26E-02	6.10E-04
Mercury	7439-97-6	1.46E-02	3.94E-04
Nickel	7440-02-0	2.85E-02	7.68E-04
Selenium	7782-49-2	1.61E-02	4.33E-04
Total chromium	7440-47-3	4.38E-03	1.18E-04
Zinc	7440-66-6	1.64E-01	4.41E-03
Other Hazardous Air Pollutants (HAPs)			
Acenaphthene	83-32-9	2.64E-02	7.65E-04
Acenaphthylene	208-96-8	3.19E-02	9.22E-04
Anthracene	120-12-7	1.79E+00	5.18E-02
Benzaldehyde	100-52-7	1.71E-01	4.93E-03
Benzo(g,h,i)perylene	191-24-2	1.26E-02	3.66E-04
Fluoranthene	206-44-0	2.02E-02	5.84E-04
Fluorene	86-73-7	9.64E-02	2.79E-03
PAHs (including naphthalene)	PAH	7.54E-01	2.18E-02
Phenanthrene	85-01-8	1.87E-01	5.42E-03
Pyrene	129-00-0	3.33E-02	9.63E-04

Notes:

[a] Based on worst-case single hour, which is deemed the cold-start hour. A cold-start hour includes 1 minute where cold-start emission rates apply, and 59 minutes where regular operation emission rates apply. For NO_X emission from Tier 4 gensets however, the cold-start emission rates apply for the first 15 minutes (time it takes for the SCR to warm up), and the regular operation emissions apply for the remaining 45 minutes.

[b] Based on a potential 12-month period where all buildings are conducting emergency operations, preventive maintenance, and stack testing, plus EAT02 and EAT03 conducting additional quinquennial testing, and EAT05 and EAT06-09 conducting additional commissioning. For EAT05 and EAT06/09, the preventive maintenance is only part of a full year to account for concurrent commissioning activities in the same year. Emissions take into account all potential cold-start hours and regular operating hours.

[c] Primary NO_2 emission is assumed to be 10% of NO_X emissions.

Table 6
Project Emissions Compared to *De Minimis* and Small-Quantity Emission Rates
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	CAS No./ID	Averaging Period	PTE	*De Minimis*	SQER	Required Action[a]
			(lb/averaging period)			
Primary NO_2	10102-44-0	1-hr	451	0.46	0.87	Model
DEEP	DEEP	year	90	0.027	0.54	Model
CO	630-08-0	1-hr	37	1.1	43	Report
SO_2	7446-09-5	1-hr	0.90	0.46	1.2	Report
Ammonia	7664-41-7	24-hr	47.81	1.9	37	Model
1,3-Butadiene	106-99-0	year	34.13	0.27	5.4	Model
Acetaldehyde	75-07-0	year	122.98	3	60	Model
Acrolein	107-02-8	24-hr	0.65	0.0013	0.026	Model
Benzene	71-43-2	year	29.25	1	21	Model
Benz(a)anthracene	56-55-3	year	0.1699	0.045	0.89	Report
Benzo(a)pyrene	50-32-8	year	0.1384	0.0082	0.16	Report
Benzo(b)fluoranthene	205-99-2	year	0.2751	0.045	0.89	Report
Benzo(k)fluoranthene	207-08-9	year	0.2703	0.045	0.89	Report
Chlorobenzene	108-90-7	24-hr	0.0038	3.7	74	--
Chrysene	218-01-9	year	0.1527	0.45	8.9	--
Dibenz(a,h)anthracene	53-70-3	year	0.1457	0.0041	0.082	Model
Ethylbenzene	100-41-4	year	1.71	3.2	65	--
Formaldehyde	50-00-0	year	270.99	1.4	27	Model
n-Hexane	110-54-3	24-hr	0.52	2.6	52	--
Hydrogen chloride	7647-01-0	24-hr	3.58	0.033	0.67	Model
Indeno(1,2,3-cd)pyrene	193-39-5	year	0.14	0.045	0.89	Report
Naphthalene	91-20-3	year	5.60	0.24	4.8	Model
Propylene	115-07-1	24-hr	8.99	11	220	--
Toluene	108-88-3	24-hr	2.03	19	370	--
m-Xylene	108-38-3	24-hr	0.42	0.82	16	--
o-Xylene	95-47-6	24-hr	0.40	0.82	16	--
Xylenes	1330-20-7	24-hr	0.82	0.82	16	--
Arsenic	7440-38-2	year	0.0754	0.0025	0.049	Model
Cadmium	7440-43-9	year	0.0706	0.0019	0.039	Model
Copper	7440-50-8	1-hr	0.0028	0.0093	0.19	--
Hexavalent chromium	18540-29-9	year	0.0047	0.000033	0.00065	Model
Lead	7439-92-1	year	0.39	10	14	--
Manganese	7439-96-5	24-hr	0.0179	0.0011	0.022	Report
Mercury	7439-97-6	24-hr	0.0115	0.00011	0.0022	Model
Nickel	7440-02-0	year	0.1837	0.031	0.62	Report
Selenium	7782-49-2	24-hr	0.0127	0.074	1.5	--
Total chromium[b]	7440-47-3	24-hr	0.0035	0.00037	0.0074	Report

Notes:

[a] Pollutants with a "Model" indicate those that require ambient air dispersion model analysis.

[b] No *de minimis* or SQER are available for total chromium, so all chromium was conservatively assumed to be chromium(III), soluble particulates.

Table 7
Best Available Control Technology Proposal
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant(s)	BACT and tBACT Proposal
Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs), and oxides of nitrogen (NO_X)	Use of EPA Tier 2-certified engines when installed and operated as emergency engines, as defined by 40 CFR 60.4219.
	Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Sulfur dioxide (SO_2)	Use of ultra-low sulfur diesel fuel or renewable diesel fuel containing no more than 15 ppm by weight of sulfur.
Toxic air pollutants, including primary nitrogen dioxide (NO_2), diesel engine exhaust particulate matter (DEEP), CO, SO_2, ammonia, 1,3-butadiene, acetaldehyde, acrolein, benzene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, formaldehyde, hydrogen chloride, indeno(1,2,3-cd)pyrene, naphthalene, arsenic, cadmium, hexavalent chromium, manganese, mercury, nickel, and total chromium.	Compliance with the proposed BACT requirements for PM, CO, VOCs, NO_X, and SO_2.

Table 8
Worst-Case Load Screening Analysis Results
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Load	Dispersion Factor 1-hour	Dispersion Factor 24-hour	Dispersion Factor Annual	Model Results[a] NO_X 1-hour	CO 1-hour	SO_2 and TAPs 1-hour	$PM_{10}/PM_{2.5}$ 24-hour	$PM_{2.5}$ Annual	NO_X Annual	DEEP Annual
	($\mu g/m^3$ per lb/hr)			($\mu g/m^3$)						
EAT02 - CAT C175 3.0 MWe Genset (Tier 2)										
10%	26	4.2	0.78	51	104	0.26	4.4	0.82	5.8	0.23
25%	32	3.8	0.71	52	127	0.56	4.3	0.82	6.0	0.21
50%	25	3.0	0.58	74	99	0.69	3.2	0.62	12	0.16
75%	24	2.9	0.56	137	182	0.83	2.3	0.45	27	0.21
100%	22	2.7	0.52	174	126	0.98	2.4	0.46	37	0.18
EAT02 - CAT C15 0.5 MWe Genset (Tier 2)										
10%	90	18	1.5	64	75	0.12	2.9	0.24	2.7	0.11
25%	73	13.2	1.28	71	51	0.17	2.4	0.23	3.9	0.14
50%	54	8.7	0.86	70	66	0.21	2.1	0.21	3.7	0.15
75%	47	6.4	0.68	52	103	0.29	1.5	0.16	2.5	0.088
100%	45	5.6	0.63	81	87	0.34	0.85	0.09	5.2	0.050
EAT03-04-05 - CAT C175 3.0 MWe Genset (Tier 4)										
10%	36	3.7	0.75	61	58	0.26	1.8	0.36	5.9	0.032
25%	25	3.2	0.68	40	20	0.39	1.5	0.31	2.1	0.029
50%	31	2.7	0.56	49	23	0.82	1.2	0.25	4.1	0.020
75%	30	2.5	0.53	77	45	1.02	0.67	0.14	9.4	0.029
100%	27	2.3	0.49	98	33	1.20	0.68	0.15	14	0.029
EAT03-04-05 - CAT C15 0.5 MWe Genset (Tier 2)										
10%	121	10.1	1.13	93	100	0.17	1.6	0.18	2.2	0.079
25%	117	8.2	0.97	99	82	0.27	1.5	0.17	3.3	0.11
50%	78	7.6	0.67	77	96	0.31	1.8	0.16	3.2	0.11
75%	62	6.4	0.53	60	135	0.38	1.5	0.12	2.2	0.069
100%	57	6.0	0.49	86	111	0.44	0.90	0.074	4.5	0.040

Table 8
Worst-Case Load Screening Analysis Results
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Load	Dispersion Factor			Model Results[a]						
	1-hour	24-hour	Annual	NO_X 1-hour	CO 1-hour	SO_2 and TAPs 1-hour	$PM_{10}/PM_{2.5}$ 24-hour	$PM_{2.5}$ Annual	NO_X Annual	DEEP Annual
	($\mu g/m^3$ per lb/hr)			($\mu g/m^3$)						
EAT06-09 - CAT C175 3.0 MWe Genset (Tier 4)										
10%	17	7.0	1.72	40	27	0.12	3.3	0.82	14	0.072
25%	14	5.6	1.48	27	11	0.22	2.6	0.69	4.5	0.064
50%	18	3.9	1.11	39	14	0.48	1.7	0.49	8.1	0.040
75%	17	3.7	1.05	55	25	0.58	1.0	0.28	18	0.057
100%	16	3.4	0.95	68	19	0.71	1.0	0.29	26	0.055
EAT06-09 - CAT C15 0.5 MWe Genset (Tier 4)										
10%	96	14.0	3.37	66	32	0.13	1.2	0.28	2.9	0.035
25%	79	9.7	2.68	48	11	0.18	0.50	0.14	0.45	0.044
50%	56	7.3	1.73	40	14	0.22	0.44	0.10	0.41	0.044
75%	48	6.3	1.36	36	21	0.29	0.44	0.095	0.45	0.027
100%	45	6.0	1.26	45	17	0.34	0.28	0.059	1.2	0.015

Note:

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

Table 9
Estimated Project Concentrations Compared to Significant Impact Levels
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	National and Washington AAQS (µg/m³)	Significant Impact Level (µg/m³) [b]	Modeled Operating Scenario	AERMOD Filename	Modeled Project Concentration[d] (µg/m³)		Location of Highest Concentration	
								UTM Easting (meters)	UTM Northing (meters)
CO	8-hour	10,000	500	Unplanned power outage	CO.1hr8hr.PO.5Y.inp	135	a	710,799.96	5,255,691.98
	1-hour	40,000	2,000	Unplanned power outage	CO.1hr8hr.PO.5Y.inp	633	a	710,574.96	5,255,791.98
SO_2	3-hour	1,310	25	Unplanned power outage	SO2.1hr3hr.PO.5Y.inp	5	a	711,312.46	5,255,391.98
	1-hour	200	7.8	Unplanned power outage	SO2.1hr3hr.PO.5Y.inp	11	a	710,962.46	5,255,729.48
PM_{10}	24-hour	150	5.0	Unplanned power outage	PM10.24hr.PO.5Y.inp	11	a	710,826.70	5,255,078.00
$PM_{2.5}$	Annual	12	0.2	Commissioning + Regular Annual	PM25.ann.SIL.5Y.inp	0.13	a, c	710,827.17	5,255,065.51
	24-hour	35	1.2	See Table 10					
NO_2	Annual	100	1.0	Commissioning + Regular Annual	NO2.ann.SIL.5Y.inp	2.9	a, c	710,827.17	5,255,065.51
	1-hour	188	7.5	See Table 10					

Notes:

[a] Reported values represent the 1st-highest modeled impacts from the project.

[b] Pollutants with modeled project concentrations above the significant impact level (highlighted in pink) will be modeled for comparison with the NAAQS.

[c] Annual averaging period modeled operating scenario is based on a potential worst case 12-month period with EAT06 and EAT09 being commissioned.

[d] Modeled project concentrations from EAT06-09.

Table 10
Estimated Project Concentrations Compared to National Ambient Air Quality Standards
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	National and Washington AAQS ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	Modeled Operating Scenario	AERMOD Filename	Modeled Concentration[i] ($\mu g/m^3$)		Background Concentration[a] ($\mu g/m^3$)	Projected Cumulative Concentration[b] ($\mu g/m^3$)	Location of Design Value Concentration	
										UTM Easting (meters)	UTM Northing (meters)
SO_2	1-hour	200	7.8	Unplanned power outage	SO2.1hr.PO.5Y.inp	23	c	10	33	711,412.46	5,255,316.98
PM_{10}	24-hour	150	5.0	Unplanned power outage	PM10.24hr.PO.5Y.inp	28	d	73	101	709,965.27	5,255,630.49
$PM_{2.5}$	24-hour	35	1.2	Commissioning - Integrated Systems Test (Level 5 Cx)	PM25.24hr.CIST.5Y.inp	1.7	e	23	24	710,862.46	5,254,991.98
NO_2	Annual	100	1.0	Commissioning + Regular Annual	NO2.ann.NAAQS.20XX.inp (input file for each year)	33	g, h	--	33	710,826.70	5,255,078.00
	1-hour	188	7.5	Monte Carlo	See Table D-3	--	f, h	--	112	711,039.74	5,255,513.22

Notes:

[a] Regional background level obtained from Idaho Department of Environmental Quality for model and monitoring data from July 2014 through June 2017 (IDEQ; accessed November 30, 2023). Local background values determined from APL concentrations at receptor identified in the center of the East Wenatchee Data Center Campus.

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

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

[d] Reported value represents the 6th-highest modeled impacts.

[e] Reported value represents the average of the maximum 3 years of modeled impact.

[f] Reported value is based on the Monte Carlo assessment for NO_2. See the Monte Carlo Analysis (Table D-3) for further details.

[g] Annual averaging period modeled based on a potential 12-month period with EAT05 being commissioned prior to installation of EAT06-09.

[h] NO_2 models include regional background from the "Quincy 3rd Avenue" monitoring station.

[i] Modeled concentrations from EAT02, EAT03-04-05, and EAT06-09 (Project).

Table 11
Estimated Project Concentrations Compared to Acceptable Source Impact Levels
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	CAS No.	Averaging Period	Facility-wide Emission Rate (lb/avg. period)	Project Concentration ($\mu g/m^3$)		ASIL ($\mu g/m^3$)
Primary NO_2	10102-44-0	1-hr	451	758		470
DEEP	DEEP	year	90	0.012	c	0.0033
Ammonia	7664-41-7	24-hr	48	3	a	500
1,3-Butadiene	106-99-0	year	34	0.004	b	0.033
Acetaldehyde	75-07-0	year	123	0.02	b	0.37
Acrolein	107-02-8	24-hr	0.65	0.042		0.35
Benzene	71-43-2	year	29	0.004	b	0.13
Dibenz(a,h)anthracene	53-70-3	year	0.15	0.00002	b	0.0005
Formaldehyde	50-00-0	year	271	0.04	b	0.17
Hydrogen chloride	7647-01-0	24-hr	3.6	0.2	a	9
Naphthalene	91-20-3	year	5.6	0.0007	b	0.029
Arsenic	7440-38-2	year	0.075	0.00001	b	0.0003
Cadmium	7440-43-9	year	0.071	0.000009	b	0.00024
Hexavalent chromium	18540-29-9	year	0.0047	0.0000006	b	0.000004
Mercury	7439-97-6	24-hr	0.012	0.0007	a	0.03

Notes:

[a] Predicted concentrations are calculated using a dispersion factor derived from the acrolein model.

[b] Predicted concentrations are calculated using a dispersion factor derived from the DEEP model.

[c] Modeled DEEP operating scenario is based on a potential worst-case 12-month period with EAT06 and EAT09 being commissioned.

Table 12
Estimated Concentrations Compared to National Ambient Air Quality Standards for Nonroad Generators
EAT06 and EAT09 Data Centers – East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	National and Washington AAQS ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	Modeled Operating Scenario	AERMOD Filename	Modeled Concentration[j] ($\mu g/m^3$)	Background Concentration[a] ($\mu g/m^3$)	Projected Cumulative Concentration[b] ($\mu g/m^3$)	Location of Design Value Concentration: UTM Easting (meters)	Location of Design Value Concentration: UTM Northing (meters)
CO	8-hour	10,000	500	Unplanned power outage	CO.1hr8hr.NAAQS.20XX.inp (input file for each year)	656 [c]	953	1,609	711,387.46	5,255,266.98
	1-hour	40,000	2,000	Unplanned power outage		2,343 [c]	1,328	3,671	711,312.46	5,255,391.98
PM_{10}	Annual	50	--	Commissioning + Regular Annual	PM25.ann.NAAQS.20XX.inp (input file for each year)	0.27 [i]	6.8	7.1	710,826.70	5,255,078.00
	24-hour	150	5.0	Unplanned power outage	PM10.24hr.NAAQS.20XX.inp (input file for each year)	25 [d]	73	98	710,835.87	5,255,081.55
$PM_{2.5}$	Annual	12	0.2	Commissioning + Regular Annual	PM25.ann.NAAQS.20XX.inp (input file for each year)	0.27 [e]	6.8	7.1	710,826.70	5,255,078.00
	24-hour	35	1.2	Commissioning - Integrated Systems Test (Level 5 Cx)	PM25.24hr.NAAQS.20XX.inp (input file for each year)	2.9 [e]	23	26	710,830.04	5,254,990.56
NO_2	Annual	100	1.0	Commissioning + Regular Annual	NO2.ann.NAAQS.20XX.inp (input file for each year)	33 [g,h]	--	33	710,826.70	5,255,078.00
	1-hour	188	7.5	Analysis not required per AQP-GUI-2010-03						

Notes:

[a] Regional background level obtained from Idaho Department of Environmental Quality for model and monitoring data from July 2014 through June 2017 (IDEQ; accessed November 30, 2023). Local background values determined from APL concentrations at receptor identified in the center of the East Wenatchee Data Center Campus.

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

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

[d] Reported value represents the 6th-highest modeled impacts.

[e] Reported value represents the average of the maximum 3 years of modeled impact.

[f] Reported value is based on the Monte Carlo assessment for NO_2. See the Monte Carlo Analysis (Table D-3) for further details.

[g] Annual averaging period modeled based on a potential 12-month period with EAT05 being commissioned prior to installation of EAT06 and EAT09.

[h] NO_2 models include regional background from the "Quincy 3rd Avenue" monitoring station.

[i] PM_{10} emissions are assumed to be the same as $PM_{2.5}$.

[j] Modeled concentrations from EAT02, EAT03-04-05, and EAT06-09 (Project).

APPENDIX A

Vendor Specification Sheets

3.0 MW Generators EAT03-04-05; EAT06-09
0.5 MW Generators EAT06-09

Mendell, Chad

From: Zach J Dieterle <ZJDieterle@petersonpower.com>
Sent: Friday, June 3, 2022 6:07 PM
To: Mendell, Chad
Cc: Unbehaun, Anthony; Gregory Darvin; Lorie Rowley (Currie & Brown, Inc); Nestor M Alvarez; Amy M Milbert; Michael Lisenbee; Sieu Quan

Subject: RE: SJC04 - Generator - Renewable Diesel
Attachments: Partial Load Performance - SJC04 (002).pdf

Question 1: I will ask CAT for a response to this. If CAT has made this commitment in the past there is no reason that they should not make the same commitment.

Question 2: The attached data table (DM8455) that you sent is for a T2 genset and represents the raw emissions coming out of the genset before the aftertreatment. The table attached to this email represents the emissions reduction performance that the ecocube provides. Expected engine emissions performance can by reducing the raw emissions data by the partial load percent reduction. The examples below uses both nominal and potential site variations emissions g/hp-hr values.

Standard ecoCUBE Performance for CAT Engines					
Genset Percent Load	100%	75%	50%	25%	10%
NOx	91%	92%	91%	91%	85%
CO	80%	80%	80%	80%	60%
VOC	50%	50%	50%	50%	40%
PM	85%	85%	85%	85%	85%

CAT C175 Emissions Data (DM8455, **Nominal**, G/HP-HR)					
Genset Percent Load	100%	75%	50%	25%	10%
Nox	6.05	5.23	3.21	2.68	6.82
CO	0.35	0.57	0.43	0.92	2.32
VOC	0.04	0.04	0.13	0.26	0.57
PM	0.03	0.04	0.04	0.09	0.2

CAT C175 Emissions Data (DM8455, **Potential Site Variation**, G/HP-HR)					
Genset Percent Load	100%	75%	50%	25%	10%
NOx	7.26	6.28	3.85	3.22	8.18
CO	0.63	1.03	0.78	1.66	4.17
VOC	0.05	0.06	0.17	0.35	0.75
PM	0.04	0.05	0.05	0.12	0.29

Emissions after ecoCUBE (**Nominal**, G/HP-HR)					
Genset Percent Load	100%	75%	50%	25%	10%
Nox	0.5445	0.4184	0.2889	0.2412	1.023
CO	0.07	0.114	0.086	0.184	0.928

VOC	0.02	0.02	0.065	0.13	0.342
PM	0.0045	0.006	0.006	0.0135	0.03

Emissions after ecoCUBE (**Potential Site Variation**, G/HP-HR)					
Genset Percent Load	100%	75%	50%	25%	10%
NOx	0.6534	0.5024	0.3465	0.2898	1.227
CO	0.126	0.206	0.156	0.332	1.668
VOC	0.025	0.03	0.085	0.175	0.45
PM	0.006	0.0075	0.0075	0.018	0.0435

On DM8455 the emission data is expressed as two values. The "Nominal" value presents data measured from an engine operated at ISO 8178 conditions. The Nominal value does not include a "Tolerance Factor" to allow for engine to engine, ambient, or measurement variation. Because the Nominal value represents the average expected emissions from this particular engine model and rating, the Nominal value can be used to develop a reasonable estimate of expected emissions from the entire population of this engine model and rating located in the airshed (if the total population and average operating hours are known). The Nominal value does not represent the highest emissions level expected during on-site measurement.

The other value provided is called "Potential Site Variation", which replaces "Not To Exceed" values that Caterpillar provided in the past. These Potential Site Variation emissions values include potential site variation due to engine-to-engine variability, ambient conditions, and emissions measurement methods. Consequently, these values are always higher than the Nominal values. These numbers are based on Caterpillar experience and expected variation in emissions during on site tests. Neither Potential Site Variation Emission values nor results of site or stack testing should be used to set permit limits as these values will not accurately represent the engine population. Nominal Emissions should be used for the purposes of setting permit limits. The Potential Site Variation values are provided by engine load. Points in between published load points can be derived by linear interpolation.

Regards,

Zach Dieterle
Account Manager - Mission Critical Datacenters
Peterson Caterpillar
510-227-9249

From: Mendell, Chad <cmendell@esdglobal.com>
Sent: Friday, June 3, 2022 11:55 AM
To: Zach J Dieterle <ZJDieterle@petersonpower.com>
Cc: Unbehaun, Anthony <AUnbehaun@esdglobal.com>; Gregory Darvin <darvin@atmosphericdynamics.com>; Lorie Rowley (Currie & Brown, Inc) <v-lrowley@microsoft.com>; Nestor M Alvarez <NMAlvarez@petersonpower.com>; Amy M Milbert <ammilbert@petersonpower.com>; Michael Lisenbee <mlisenbee@davidjpowers.com>; Sieu Quan <sieuquan@microsoft.com>
Subject: SJC04 - Generator - Renewable Diesel

Zach,

I have two questions related to using renewable diesel fuel with the Caterpillar 3000kW Tier IV emission generators for the Microsoft SJC04 project:

- **Question #1:** Can the generator hardware (without changing the engine or alternator) be re-rated to achieve the full 3000 kW required by Microsoft when using renewable diesel. (We have been told that the answer is yes on other project sites).

- **Question #2:** If Question #1 is yes, does the attached Tier IV emissions table still apply since the top kW in this data form is 3100 kW? (We ultimately need a Tier IV emissions data sheet for this scenario).

Thank you for your help.

Chad Mendell
Studio Leader
Shareholder

Environmental Systems Design, Inc.
Improving Society Through the Built Environment
312 456 2387 direct | 312 953 9141 mobile
esdglobal.com | cmendell@esdglobal.com

safety POWER

clean essential energy

Attn: Zach Dieterle
Account Manager - Mission Critical Datacenters
October 28, 2022

ecoCUBE® System Warranty Statement

Zach,

Please note the following details relating to the warranty coverage offered with our latest proposal #22298 Rev1.1:

- The project phase covered is EAT03 (20 ecoCUBE® systems as outlined in the summary table of the proposal on page 2).
- The manufacturer of the emission control devices being offered is Safety Power Inc. (SPI)
- Should the 5-year extended parts-only warranty outlined in the summary table of the proposal be purchased, the warranty period for the ecoCUBE® reactor housing, urea injection and control system would become 5 years in accordance with the System Warranty section of the proposal on page 18.
- The SCR catalyst is separately warranted for a period of 8,000 hours in accordance with the technical guarantee section of the proposal on page 14. If the 5-year extended parts-only warranty option is purchased, the catalyst pro-rata period would be increased to align (also 5 years).
- The DPF substrate requires mechanical cleaning every 800-1500 hrs. Mechanical cleaning is considered a maintenance item and is not covered by the warranty.
- The above warranty assumes that the system is operated as per Safety Power's O&M manual. Failure to complete regular maintenance or operation of the system beyond normal conditions may void the warranty.

John Grousopoulos, P.Eng

Applications Engineer
Safety Power Inc.
647-806-3548

safety POWER

clean essential energy

SUMMARY

Dear Zach,

Safety Power is pleased to submit the following proposal for the ecoCUBE® Emissions Control System with Selective Catalytic Reduction (SCR) + DPF for the CAT Diesel generator sets operating in accordance with engine performance as per published data sheets at "Stand-by" operating point. This proposal is for a proven system for this size of engine.

Base Bid to reduce the emissions down to Tier 4f Compliant levels for NOx, CO, NMHC & PM.

The submitted pricing is based on the supply and commissioning only – installation will be by OTHERS.

Base-Bid Guaranteed Emissions Reductions per Table 2 for the Engines	**(20) x ecoCUBEs for CAT C175-16 per Table 4** **Additional ecoCUBE system accessories for CAT C175-16 as per Table 5** **5-year extended parts-only warranty**

Safety Power is a global innovator and a leading supplier for large stationary engines. Safety Power has the **technical resources** to provide support during installation and throughout the life of the equipment.

Key features and benefits of the proposed system include:

- Safety Power's ecoCUBE® system will be designed with its proprietary **Closed Loop control** system to provide NOx emissions reduction performance throughout varying engine loads while minimizing ammonia slip
- SCR reactor housing, mixing duct are fabricated from durable **409 stainless steel** and the static mixers, turning vanes and injection lance from **304 stainless steel.**
- The proprietary catalyst used in the SCR reactor is a homogeneous design providing superior emissions reduction in a compact configuration with superior spalling and degradation resistance over the life of the catalyst.
- The SCR control and dosing system is designed with an industrial grade **urea injection pump system** for maximum reliability and precise control

Technical Guarantee

The system and catalytic material shall be warranted in accordance with the standard Performance & System Warranty (attached).

Safety Power warrants the quality and suitability of the materials, design and construction of the supplies and services and their qualification for the application. Provided the design data is adhered to, Safety Power guarantees the output values as shown in Table 2 and the Performance & System Warranty.

The maximum allowed temperature entering the Catalyst is 950°F (for NOx reduction). Above 950° F, the SCR catalyst activity can be degraded over time. System performance can't be guaranteed if large variations exist in the full load NOx output of the engine (> +/- 20%) while the generator is operating at a steady state electrical output.

If the engine runs with an exhaust temperature below 410°F (for ULSD or Pipe Line Natural Gas), the SCR control system will stop the injection of urea. This will prevent the formation of ammonium (bi) sulfate on the SCR catalyst surface. Full load NOx reduction will not be achieved at exhaust temperatures less than 540°F.

The SCR Catalyst is warranted from defects for a period of 8,000 hours (2-years pro-rata), based in accordance with the operation manual. If the proposed system also includes an Oxidation Catalyst or Oxidation Catalyst Modules, this catalyst is warranted for 8,000 hours (2-years pro-rata), based in accordance with the operation manual. Any deficiencies in the supplies and services provided by Safety Power must be reported by the buyer in writing without delay. These deficiencies will be remedied to the exclusion of any further guarantee claims and rights, accordingly to our warranty statement and our standard terms and conditions. The supplied equipment, excluding the catalyst and labor, is guaranteed for 12 months starting from the date of commissioning and acceptance of the system but no longer than 18 months after delivery or purchase order required ship date. This warranty is not transferable.

d) Periodic cleaning of particulates, etc., may be found necessary to maintain catalyst activity. If required, this shall not be construed as evidence of catalyst non-performance. For systems with Diesel Particulate Filters (DPF) the warranty does not cover plugged filters. Buyer shall conduct catalyst and DPF cleaning in strict accordance with SPI procedure during warranty period.

System Warranty

6) The warranty period for the SCR reactor housing, urea injection and control system is (12 months from date of acceptance) set forth in the Warranty Section of proposal but not longer than 18 months after delivery or PO required ship date. This warranty assumes that the Buyer adheres to proper operation and maintenance procedures as provided in the Safety Power Inc. Operation and Maintenance Manual. The items listed in items a) through g) below should be considered when using the Safety Power Inc. emissions reduction system:

a) The warranty for the urea injection system does not include parts that need to be replaced due to normal wear from use of the system. The following are considered normal wear parts: spray nozzle liquid cap and air cap, pumps, urea filters, pressure gauges, valves, and flow meters.

b) The functionality of the SCR system is based on the Buyer purchasing a urea that is compatible with the Safety Power Inc. injection system and catalyst. A urea solution that is high in particulate matter may cause the urea filter to clog prematurely. A urea solution that contains high concentrations of the known catalyst poisons stated in section 5a will result in premature failure of the SCR catalyst. Failure to use a Safety Power approved urea supplier will void the warranty.

c) The Safety Power urea injection system was designed based on the information in the Design Parameters Section of proposal

d) Unless otherwise expressly indicated in the Proposal, use of fuels in excess of 50 ppm sulphur or other contaminants will void the warranty.

e) Unless expressly included in SPI’s scope of supply the responsibility for allowing for thermal expansion of the products supplied by SPI is “by others”. Any damage caused as a result of inadequate thermal expansion allowance at installation or design time is not the responsibility of SPI.

f) Provided the exhaust system meets design criteria as stipulated in NFPA 68, damage to the System caused by an engine backfire or other engine malfunction is covered by the warranty.

g) Unless otherwise expressly indicated in the Proposal, this warranty is for materials only. Buyer is responsible for shipping and labour costs to install or replace any of the materials supplied by SPI.

h) The supply of replacement parts under this warranty shall not extend the warranty period.

7) THE LIMITED WARRANTY PROVIDED ABOVE IS THE SOLE AND EXCLUSIVE WARRANTY OF SPI IN CONNECTION WITH THE SUPPLY OF THE SPI CATALYST SYSTEM. SPI MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE. FURTHER, THE LIMITED WARRANTY SET FORTH DOES NOT APPLY TO THE RESULTS OF ACCIDENT, ABUSE, NEGLECT, VANDALISM, ACT OF GOD, USE CONTRARY TO SPI’S INSTRUCTIONS OR THE TERMS AND CONDITIONS OF THIS WARRANTY, IMPROPER INSTALLATION, REPAIR, REPLACEMENT OR MODIFICATION BY ANYONE OTHER THAN SPI (EXCEPT WITH SPI’S WRITTEN APPROVAL).

8) The foregoing is Seller’s only obligation and Buyer’s exclusive remedy for breach of warranty and, except for gross negligence, wilful misconduct and remedies permitted under the performance, inspection and acceptance and the patent clauses hereof, the foregoing is Buyer’s exclusive remedy against Seller for all claims arising hereunder or relating hereto whether such claims are based on breach of contract, (or) (including negligence and strict liability) or other theories.

Buyer’s failure to submit a claim as provided above shall specifically waive all claims based on latent defects. In no event shall Buyer be entitled to incidental or consequential damages. Any action arising hereunder or relating hereto whether based on breach of contract (or) (including negligence and strict liability) or other theories, must be commenced within one (1) year after the cause of action accrues or it shall be barred.

Performance Number: DM8455 **Change Level: 14**

SALES MODEL:	C175-16	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
MACHINE SALES MODEL:		**HERTZ:**	60
ENGINE POWER (BHP):	4,376	**ASPIRATION:**	TA
GEN POWER W/O FAN (EKW):	3,100.0	**AFTERCOOLER TYPE:**	SCAC
COMPRESSION RATIO:	15.3	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC+1AC, 2AC
RATING LEVEL:	STANDBY	**AFTERCOOLER TEMP (F):**	115
PUMP QUANTITY:	2	**JACKET WATER TEMP (F):**	210.2
FUEL TYPE:	DIESEL	**TURBO CONFIGURATION:**	PARALLEL
MANIFOLD TYPE:	DRY	**TURBO QUANTITY:**	4
GOVERNOR TYPE:	ADEM4	**TURBOCHARGER MODEL:**	GTB6251BN-48T-1.38
ELECTRONICS TYPE:	ADEM4	**CERTIFICATION YEAR:**	2008
CAMSHAFT TYPE:	STANDARD	**CRANKCASE BLOWBY RATE (FT3/HR):**	2,436.4
IGNITION TYPE:	CI	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	15.5
INJECTOR TYPE:	CR	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,598.4
FUEL INJECTOR:	4439455		
REF EXH STACK DIAMETER (IN):	14		

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

General Performance Data

GENSET POWER WITHOUT 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
3,100.0	100	4,376	373	0.339	0.331	209.0	204.0	0.478	0.467
2,790.0	90	3,938	335	0.338	0.330	187.6	183.1	0.477	0.466
2,480.0	80	3,501	298	0.341	0.333	168.5	164.5	0.482	0.470
2,325.0	75	3,282	279	0.347	0.338	160.4	156.6	0.489	0.478
2,170.0	70	3,063	261	0.355	0.346	153.2	149.6	0.501	0.489
1,860.0	60	2,626	224	0.376	0.368	139.4	136.0	0.531	0.519
1,550.0	50	2,188	186	0.402	0.393	124.1	121.1	0.568	0.554
1,240.0	40	1,750	149	0.424	0.414	104.6	102.1	0.599	0.584
930.0	30	1,313	112	0.448	0.438	83.0	81.0	0.633	0.618
775.0	25	1,094	93	0.463	0.452	71.4	69.7	0.653	0.638
620.0	20	875	75	0.481	0.470	59.4	58.0	0.680	0.663
310.0	10	438	37	0.551	0.538	34.0	33.2	0.778	0.760

GENSET POWER WITHOUT 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
3,100.0	100	4,376	90.3	131.1	1,225.5	63.4	890.4	91	447.1
2,790.0	90	3,938	80.1	129.4	1,188.6	55.5	877.6	81	409.8
2,480.0	80	3,501	71.6	128.1	1,158.3	49.1	868.0	73	380.1
2,325.0	75	3,282	68.5	127.7	1,147.4	46.8	865.1	70	370.1
2,170.0	70	3,063	66.2	127.5	1,139.4	45.1	863.6	68	363.4
1,860.0	60	2,626	61.6	127.2	1,123.9	42.1	860.9	64	350.8
1,550.0	50	2,188	54.8	126.7	1,104.1	38.0	855.9	57	332.0
1,240.0	40	1,750	42.8	125.4	1,072.5	30.6	844.6	47	296.3
930.0	30	1,313	30.8	124.0	1,023.2	22.6	829.2	35	251.2
775.0	25	1,094	24.8	123.3	984.4	18.6	812.8	28	225.1
620.0	20	875	18.9	122.8	892.3	14.9	749.2	22	197.3
310.0	10	438	6.9	121.7	643.1	7.8	569.8	9	135.2

General Performance Data (Continued)

GENSET POWER WITHOUT 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
3,100.0	100	4,376	9,674.6	25,320.3	42,304.4	43,785.9	9,221.5	8,576.0
2,790.0	90	3,938	8,834.8	22,758.0	38,384.4	39,715.1	8,367.4	7,787.1
2,480.0	80	3,501	8,133.6	20,653.4	35,133.9	36,329.8	7,648.7	7,127.4
2,325.0	75	3,282	7,873.5	19,883.5	33,933.2	35,071.5	7,379.4	6,882.8
2,170.0	70	3,063	7,674.4	19,303.2	33,017.6	34,104.9	7,172.3	6,697.1
1,860.0	60	2,626	7,287.7	18,220.5	31,272.8	32,261.2	6,783.7	6,349.9
1,550.0	50	2,188	6,739.4	16,826.5	28,846.8	29,726.1	6,288.4	5,901.2
1,240.0	40	1,750	5,792.8	14,535.8	24,673.2	25,413.7	5,479.6	5,153.6
930.0	30	1,313	4,845.5	11,851.1	20,542.1	21,129.9	4,521.1	4,261.0
775.0	25	1,094	4,371.7	10,369.7	18,492.5	18,998.8	4,006.8	3,781.7
620.0	20	875	3,897.7	8,845.4	16,453.5	16,874.9	3,597.6	3,409.5
310.0	10	438	2,949.2	5,561.0	12,407.4	12,648.6	2,655.9	2,544.6

Heat Rejection Data

PUMP POWER IS INCLUDED IN HEAT REJECTION BALANCE, BUT IS NOT SHOWN.

GENSET POWER WITHOUT FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM 2ND STAGE 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
3,100.0	100	4,376	77,079	8,233	176,058	100,091	24,081	27,356	185,573	452,113	481,614
2,790.0	90	3,938	68,674	7,617	157,585	88,535	21,506	22,077	167,015	403,771	430,117
2,480.0	80	3,501	61,730	7,130	142,543	79,399	19,247	18,045	148,458	361,362	384,941
2,325.0	75	3,282	58,955	6,949	136,754	76,169	18,272	16,609	139,179	343,060	365,445
2,170.0	70	3,063	56,877	6,821	132,798	73,794	17,456	15,731	129,901	327,733	349,118
1,860.0	60	2,626	53,228	6,605	125,732	69,340	15,919	14,476	111,343	298,886	318,389
1,550.0	50	2,188	49,412	6,441	117,165	63,168	14,300	13,183	92,786	268,478	285,997
1,240.0	40	1,750	44,006	6,297	102,298	52,689	12,215	10,300	74,229	229,338	244,303
930.0	30	1,313	37,226	6,186	83,787	42,347	9,854	7,429	55,672	184,999	197,070
775.0	25	1,094	33,267	6,118	73,173	36,703	8,568	6,178	46,393	160,871	171,368
620.0	20	875	28,325	5,745	61,741	27,923	7,209	5,244	37,114	135,351	144,182
310.0	10	438	16,748	4,702	36,241	11,322	4,278	3,828	18,557	80,318	85,559

Sound Data

SOUND DATA REPRESENTATIVE OF NOISE PRODUCED BY THE "ENGINE ONLY"

EXHAUST:SOUND POWER(1/3 Octave Frequencies)

GENSET POWER WITHOUT FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,100.0	100	4,376	134.4	109.7	115.8	113.6	115.4	115.8	118.8	119.7	121.4	120.2	121.0
2,790.0	90	3,938	133.1	110.4	116.2	112.4	114.1	114.3	117.1	118.2	119.8	118.1	119.2
2,480.0	80	3,501	131.8	111.9	116.7	110.7	112.5	112.8	115.3	116.7	118.2	116.2	117.4
2,325.0	75	3,282	131.1	112.7	116.9	109.8	111.6	112.0	114.5	115.9	117.3	115.3	116.4
2,170.0	70	3,063	130.5	113.5	117.2	108.9	110.7	111.3	113.6	115.2	116.4	114.4	115.5
1,860.0	60	2,626	129.2	115.1	117.7	107.1	109.0	109.8	111.9	113.7	114.7	112.6	113.6
1,550.0	50	2,188	127.9	116.8	118.2	105.3	107.3	108.4	110.2	112.3	113.0	110.7	111.7
1,240.0	40	1,750	126.6	118.4	118.7	103.5	105.6	106.9	108.4	110.8	111.3	108.9	109.8
930.0	30	1,313	125.3	120.0	119.2	101.7	103.9	105.4	106.7	109.3	109.5	107.1	107.9
775.0	25	1,094	124.6	120.8	119.5	100.8	103.0	104.7	105.8	108.6	108.7	106.2	106.9
620.0	20	875	124.0	121.6	119.7	99.9	102.1	103.9	105.0	107.8	107.8	105.3	106.0
310.0	10	438	122.7	123.2	120.3	98.1	100.4	102.5	103.2	106.4	106.1	103.4	104.1

EXHAUST:SOUND POWER(1/3 Octave Frequencies)

GENSET POWER	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ

WITHOUT FAN													
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,100.0	100	4,376	122.0	122.4	123.4	124.7	124.5	122.9	122.2	121.4	119.9	118.8	123.5
2,790.0	90	3,938	120.5	120.8	122.0	123.4	123.0	121.3	120.6	119.8	118.6	117.7	123.8
2,480.0	80	3,501	119.2	119.5	120.6	122.3	121.7	120.2	119.7	118.9	117.5	117.0	123.5
2,325.0	75	3,282	118.5	118.9	119.8	121.8	121.0	119.7	119.2	118.4	117.0	116.7	123.2
2,170.0	70	3,063	117.9	118.3	119.1	121.2	120.4	119.1	118.8	118.0	116.4	116.4	123.0
1,860.0	60	2,626	116.5	117.1	117.6	120.2	119.0	118.1	117.9	117.1	115.4	115.8	122.5
1,550.0	50	2,188	115.2	115.8	116.2	119.1	117.7	117.0	117.0	116.2	114.3	115.1	122.0
1,240.0	40	1,750	113.9	114.6	114.7	118.1	116.4	116.0	116.1	115.3	113.3	114.5	121.5
930.0	30	1,313	112.6	113.4	113.2	117.0	115.1	114.9	115.2	114.4	112.2	113.9	121.0
775.0	25	1,094	112.0	112.8	112.5	116.5	114.5	114.4	114.8	114.0	111.7	113.6	120.7
620.0	20	875	111.3	112.2	111.8	116.0	113.8	113.9	114.4	113.6	111.2	113.3	120.5
310.0	10	438	110.0	110.9	110.3	115.0	112.5	112.8	113.5	112.7	110.2	112.6	120.0

MECHANICAL:SOUND POWER(1/3 Octave Frequencies)

GENSET POWER WITHOUT FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,100.0	100	4,376	125.9	89.8	105.6	98.3	100.7	104.3	108.4	111.5	113.2	112.5	114.1
2,790.0	90	3,938	125.8	89.3	105.5	97.9	100.9	103.2	108.7	111.1	112.6	112.2	113.7
2,480.0	80	3,501	126.0	88.9	104.9	97.8	99.6	102.3	107.8	111.0	111.6	111.8	112.9
2,325.0	75	3,282	126.1	88.7	104.5	97.8	98.8	101.9	107.3	111.0	111.1	111.7	112.5
2,170.0	70	3,063	126.3	88.5	104.2	97.8	98.0	101.5	106.8	111.0	110.6	111.5	112.0
1,860.0	60	2,626	126.5	88.0	103.5	97.8	96.5	100.7	105.8	111.0	109.5	111.1	111.2
1,550.0	50	2,188	126.8	87.6	102.8	97.8	95.0	99.9	104.8	111.0	108.5	110.8	110.3
1,240.0	40	1,750	127.0	87.2	102.2	97.7	93.5	99.2	103.8	110.9	107.5	110.5	109.5
930.0	30	1,313	127.3	86.7	101.5	97.7	92.0	98.4	102.8	110.9	106.5	110.1	108.6
775.0	25	1,094	127.4	86.5	101.1	97.7	91.2	98.0	102.3	110.9	105.9	109.9	108.2
620.0	20	875	127.5	86.3	100.8	97.7	90.5	97.6	101.8	110.9	105.4	109.8	107.8
310.0	10	438	127.8	85.9	100.1	97.7	89.0	96.8	100.8	110.9	104.4	109.4	106.9

MECHANICAL:SOUND POWER(1/3 Octave Frequencies)

GENSET POWER WITHOUT FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,100.0	100	4,376	112.7	113.9	114.6	115.3	114.9	112.7	110.8	111.8	114.2	113.3	117.9
2,790.0	90	3,938	112.5	113.7	114.4	114.9	114.4	112.2	110.3	111.0	113.6	112.8	119.5
2,480.0	80	3,501	112.1	113.1	113.7	114.3	114.2	111.8	109.9	110.6	113.1	112.6	121.8
2,325.0	75	3,282	111.9	112.8	113.3	113.9	114.1	111.6	109.8	110.4	112.9	112.5	123.1
2,170.0	70	3,063	111.7	112.5	112.8	113.6	114.0	111.4	109.6	110.3	112.6	112.4	124.3
1,860.0	60	2,626	111.2	111.9	112.0	112.9	113.8	110.9	109.2	109.9	112.2	112.2	126.8
1,550.0	50	2,188	110.8	111.3	111.1	112.2	113.7	110.5	108.9	109.6	111.8	112.1	129.3
1,240.0	40	1,750	110.4	110.7	110.3	111.5	113.5	110.1	108.5	109.2	111.3	111.9	131.8
930.0	30	1,313	110.0	110.1	109.4	110.8	113.3	109.6	108.2	108.8	110.9	111.7	134.2
775.0	25	1,094	109.7	109.8	109.0	110.5	113.2	109.4	108.0	108.7	110.7	111.6	135.5
620.0	20	875	109.5	109.5	108.6	110.2	113.1	109.2	107.8	108.5	110.5	111.5	136.7
310.0	10	438	109.1	108.9	107.8	109.5	112.9	108.8	107.5	108.1	110.0	111.3	139.2

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITHOUT FAN	EKW	3,100.0	2,790.0	2,325.0	1,550.0	775.0	310.0
PERCENT LOAD	%	100	90	75	50	25	10
ENGINE POWER	BHP	4,376	3,938	3,282	2,188	1,094	438
TOTAL NOX (AS	G/HR	26,403	22,877	17,130	7,010	2,936	2,988

NO2)								
TOTAL CO		G/HR	1,524	1,842	1,866	947	1,012	1,015
TOTAL HC		G/HR	179	143	147	279	284	248
TOTAL CO2		KG/HR	2,206	1,942	1,619	1,240	696	327
PART MATTER		G/HR	116.1	122.8	119.3	86.1	96.8	89.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,107.8	3,068.3	2,704.7	1,443.3	1,095.5	2,281.7
TOTAL CO	(CORR 5% O2)	MG/NM3	157.9	222.1	252.1	164.2	321.9	666.1
TOTAL HC	(CORR 5% O2)	MG/NM3	15.2	13.1	17.6	43.3	78.1	141.4
PART MATTER	(CORR 5% O2)	MG/NM3	10.3	12.5	14.0	13.4	27.5	54.3
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	1,153.2	1,138.5	1,003.6	535.6	406.5	846.7
TOTAL CO	(CORR 15% O2)	MG/NM3	58.6	82.4	93.6	60.9	119.5	247.2
TOTAL HC	(CORR 15% O2)	MG/NM3	5.7	4.8	6.5	16.1	29.0	52.5
PART MATTER	(CORR 15% O2)	MG/NM3	3.8	4.6	5.2	5.0	10.2	20.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,514	1,494	1,317	703	534	1,111
TOTAL CO	(CORR 5% O2)	PPM	126	178	202	131	258	533
TOTAL HC	(CORR 5% O2)	PPM	28	24	33	81	146	264
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	562	555	489	261	198	412
TOTAL CO	(CORR 15% O2)	PPM	47	66	75	49	96	198
TOTAL HC	(CORR 15% O2)	PPM	11	9	12	30	54	98
TOTAL NOX (AS NO2)		G/HP-HR	6.05	5.82	5.23	3.21	2.68	6.82
TOTAL CO		G/HP-HR	0.35	0.47	0.57	0.43	0.92	2.32
TOTAL HC		G/HP-HR	0.04	0.04	0.04	0.13	0.26	0.57
PART MATTER		G/HP-HR	0.03	0.03	0.04	0.04	0.09	0.20
TOTAL NOX (AS NO2)		G/KW-HR	8.23	7.92	7.11	4.36	3.65	9.27
TOTAL CO		G/KW-HR	0.48	0.64	0.77	0.59	1.26	3.15
TOTAL HC		G/KW-HR	0.06	0.05	0.06	0.17	0.35	0.77
PART MATTER		G/KW-HR	0.04	0.04	0.05	0.05	0.12	0.28
TOTAL NOX (AS NO2)		LB/HR	58.21	50.43	37.76	15.45	6.47	6.59
TOTAL CO		LB/HR	3.36	4.06	4.11	2.09	2.23	2.24
TOTAL HC		LB/HR	0.39	0.31	0.32	0.62	0.63	0.55
TOTAL CO2		LB/HR	4,863	4,281	3,570	2,735	1,535	720
PART MATTER		LB/HR	0.26	0.27	0.26	0.19	0.21	0.20
OXYGEN IN EXH		%	9.6	9.8	10.3	11.7	12.9	15.2
DRY SMOKE OPACITY		%	0.3	0.7	0.7	0.0	0.7	2.4
BOSCH SMOKE NUMBER			0.70	0.73	0.74	0.64	0.74	0.90

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITHOUT FAN		**EKW**	**3,100.0**	**2,790.0**	**2,325.0**	**1,550.0**	**775.0**	**310.0**
PERCENT LOAD		**%**	**100**	**90**	**75**	**50**	**25**	**10**
ENGINE POWER		BHP	4,376	3,938	3,282	2,188	1,094	438
TOTAL NOX (AS NO2)		G/HR	31,683	27,452	20,556	8,412	3,523	3,586
TOTAL CO		G/HR	2,743	3,316	3,359	1,704	1,822	1,827
TOTAL HC		G/HR	238	190	195	372	378	330
PART MATTER		G/HR	162.5	171.9	167.1	120.5	135.6	125.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,729.4	3,681.9	3,245.7	1,732.0	1,314.5	2,738.0
TOTAL CO	(CORR 5% O2)	MG/NM3	284.3	399.8	453.8	295.6	579.5	1,199.1
TOTAL HC	(CORR 5% O2)	MG/NM3	20.3	17.4	23.4	57.6	103.9	188.1
PART MATTER	(CORR 5% O2)	MG/NM3	14.4	17.5	19.7	18.8	38.6	76.0
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	1,383.9	1,366.3	1,204.4	642.7	487.8	1,016.0
TOTAL CO	(CORR 15% O2)	MG/NM3	105.5	148.3	168.4	109.7	215.0	444.9
TOTAL HC	(CORR 15% O2)	MG/NM3	7.5	6.4	8.7	21.4	38.5	69.8
PART MATTER	(CORR 15% O2)	MG/NM3	5.3	6.5	7.3	7.0	14.3	28.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,817	1,793	1,581	844	640	1,334
TOTAL CO	(CORR 5% O2)	PPM	227	320	363	236	464	959
TOTAL HC	(CORR 5% O2)	PPM	38	32	44	108	194	351
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	674	665	587	313	238	495
TOTAL CO	(CORR 15% O2)	PPM	84	119	135	88	172	356
TOTAL HC	(CORR 15% O2)	PPM	14	12	16	40	72	130
TOTAL NOX (AS NO2)		G/HP-HR	7.26	6.99	6.28	3.85	3.22	8.18
TOTAL CO		G/HP-HR	0.63	0.84	1.03	0.78	1.66	4.17

TOTAL HC	G/HP-HR	0.05	0.05	0.06	0.17	0.35	0.75
PART MATTER	G/HP-HR	0.04	0.04	0.05	0.06	0.12	0.29
TOTAL NOX (AS NO2)	G/KW-HR	9.87	9.50	8.53	5.23	4.38	11.13
TOTAL CO	G/KW-HR	0.86	1.15	1.39	1.06	2.26	5.67
TOTAL HC	G/KW-HR	0.07	0.07	0.08	0.23	0.47	1.03
PART MATTER	G/KW-HR	0.05	0.06	0.07	0.07	0.17	0.39
TOTAL NOX (AS NO2)	LB/HR	69.85	60.52	45.32	18.54	7.77	7.91
TOTAL CO	LB/HR	6.05	7.31	7.41	3.76	4.02	4.03
TOTAL HC	LB/HR	0.52	0.42	0.43	0.82	0.83	0.73
PART MATTER	LB/HR	0.36	0.38	0.37	0.27	0.30	0.28

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

ALTITUDE DERATE DATA IS BASED ON THE ASSUMPTION OF A 20 DEGREES CELSIUS(36 DEGREES FAHRENHEIT) DIFFERENCE BETWEEN AMBIENT OPERATING TEMPERATURE AND ENGINE INLET SCAC TEMPERATURE. AMBIENT OPERATING TEMPERATURE IS DEFINED AS THE AIR TEMPERATURE MEASURED AT THE TURBOCHARGER COMPRESSOR INLET.

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	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376
1,000	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376
2,000	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,355	4,376
3,000	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,376	4,309	4,216	4,376
4,000	4,345	4,345	4,345	4,345	4,345	4,345	4,344	4,344	4,343	4,280	4,190	4,100	4,345
5,000	4,174	4,174	4,174	4,174	4,174	4,174	4,173	4,172	4,170	4,130	4,073	4,017	4,174
6,000	4,015	4,015	4,015	4,015	4,015	4,015	4,013	4,011	4,008	3,988	3,960	3,933	4,015
7,000	3,868	3,868	3,868	3,868	3,868	3,868	3,866	3,863	3,859	3,853	3,847	3,840	3,868
8,000	3,751	3,751	3,751	3,751	3,751	3,751	3,749	3,745	3,742	3,736	3,729	3,723	3,751
9,000	3,634	3,634	3,634	3,634	3,634	3,634	3,633	3,628	3,624	3,618	3,612	3,606	3,634
10,000	3,523	3,523	3,523	3,523	3,523	3,523	3,521	3,517	3,512	3,506	3,500	3,495	3,523
11,000	3,417	3,417	3,417	3,417	3,417	3,417	3,415	3,411	3,406	3,400	3,394	3,388	3,417
12,000	3,312	3,312	3,312	3,312	3,312	3,312	3,310	3,304	3,299	3,294	3,288	3,282	3,312
13,000	3,206	3,206	3,206	3,206	3,206	3,206	3,204	3,198	3,193	3,188	3,182	3,176	3,206
14,000	3,100	3,100	3,100	3,100	3,100	3,100	3,098	3,093	3,088	3,083	3,079	3,074	3,100
15,000	2,993	2,993	2,993	2,993	2,993	2,993	2,991	2,988	2,984	2,981	2,977	2,974	2,993

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K9167	LL6027	3079788	GS265	-	WYB00620	
0K9167	LL6027	5683569	PG323	-	TB800100	
0K9167	LL6027	5717349	PG323	-	TB800100	

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

PERFORMANCE DATA[DM8455]

On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 10/27/21

0.5 MW generators EAT03-04-05, EAT06-09

PERFORMANCE DATA[DM8155]

March 11, 2022

Performance Number: DM8155 | **Change Level: 05**

SALES MODEL:	C15	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
MACHINE SALES MODEL:		**HERTZ:**	60
ENGINE POWER (BHP):	762	**FAN POWER (HP):**	19.4
GEN POWER WITH FAN (EKW):	500.0	**ADDITIONAL PARASITICS (HP):**	14.2
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):**	120
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	192.2
GOVERNOR TYPE:	ELEC	**TURBO CONFIGURATION:**	SINGLE
CAMSHAFT TYPE:	STANDARD	**TURBO QUANTITY:**	1
IGNITION TYPE:	CI	**TURBOCHARGER MODEL:**	GTA5518BS-56T-1.58
INJECTOR TYPE:	EUI	**CERTIFICATION YEAR:**	2006
REF EXH STACK DIAMETER (IN):	6	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,025.0
MAX OPERATING ALTITUDE (FT):	3,281		

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)	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
500.0	100	762	361	0.333	0.330	35.7	35.4	0.507	0.497
450.0	90	683	324	0.348	0.345	33.5	33.2	0.528	0.518
400.0	80	607	288	0.358	0.355	30.6	30.3	0.543	0.533
375.0	75	570	271	0.358	0.355	28.8	28.5	0.545	0.535
350.0	70	534	253	0.356	0.353	26.8	26.5	0.543	0.533
300.0	60	462	219	0.347	0.344	22.6	22.4	0.535	0.525
250.0	50	392	186	0.336	0.333	18.6	18.4	0.527	0.517
200.0	40	323	153	0.339	0.336	15.4	15.3	0.547	0.536
150.0	30	253	120	0.347	0.344	12.4	12.3	0.586	0.575
125.0	25	218	103	0.355	0.352	10.9	10.8	0.619	0.607
100.0	20	182	86	0.368	0.364	9.4	9.4	0.670	0.657
50.0	10	109	52	0.420	0.416	6.5	6.4	0.917	0.900

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	762	68.2	120.4	1,296.3	46.8	988.0	73	405.8
450.0	90	683	67.0	119.4	1,280.7	45.9	973.8	72	402.2
400.0	80	607	61.6	115.2	1,250.1	42.3	956.6	66	381.3
375.0	75	570	56.4	111.0	1,229.5	38.8	947.8	61	361.0
350.0	70	534	50.1	106.0	1,205.6	34.6	938.3	54	336.1
300.0	60	462	36.6	95.5	1,148.6	25.6	915.7	40	282.1
250.0	50	392	24.0	86.2	1,080.0	17.4	887.9	27	229.6
200.0	40	323	16.9	83.6	1,003.8	13.3	838.1	19	195.0
150.0	30	253	11.3	81.0	910.6	10.2	768.4	13	165.5
125.0	25	218	9.1	79.8	857.1	9.0	725.6	11	152.7
100.0	20	182	7.0	78.6	795.3	8.0	674.7	9	140.6
50.0	10	109	3.3	76.2	639.0	6.1	542.9	5	118.5

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

500.0	100	762	1,347.7	3,605.5	6,001.8	6,255.3	1,224.6	1,109.4
450.0	90	683	1,345.2	3,558.0	5,981.4	6,219.2	1,220.4	1,110.6
400.0	80	607	1,283.7	3,364.8	5,686.7	5,904.2	1,168.1	1,066.0
375.0	75	570	1,219.4	3,187.1	5,381.2	5,585.8	1,113.3	1,016.3
350.0	70	534	1,139.2	2,970.6	5,001.5	5,191.7	1,044.7	953.4
300.0	60	462	965.5	2,500.8	4,183.5	4,344.1	894.0	815.5
250.0	50	392	799.0	2,040.7	3,407.8	3,539.6	744.6	679.6
200.0	40	323	697.8	1,729.1	2,959.9	3,069.2	655.1	600.0
150.0	30	253	615.8	1,447.5	2,601.3	2,689.1	579.6	534.1
125.0	25	218	581.8	1,317.2	2,454.7	2,532.1	546.4	505.6
100.0	20	182	551.1	1,190.0	2,322.2	2,389.2	515.8	479.7
50.0	10	109	497.4	940.2	2,088.6	2,134.4	461.1	434.6

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	762	10,375	5,182	28,039	17,119	4,138	6,860	32,301	77,688	82,757
450.0	90	683	9,686	4,904	27,298	16,583	3,881	6,775	28,958	72,867	77,622
400.0	80	607	8,796	4,826	25,540	15,270	3,549	6,061	25,750	66,626	70,974
375.0	75	570	8,322	4,716	24,127	14,230	3,337	5,388	24,187	62,652	66,740
350.0	70	534	7,911	4,524	22,387	13,011	3,104	4,610	22,642	58,272	62,074
300.0	60	462	7,240	4,038	18,412	10,458	2,621	3,127	19,611	49,217	52,428
250.0	50	392	6,630	3,455	14,380	8,084	2,153	1,957	16,633	40,417	43,054
200.0	40	323	5,924	2,968	11,812	6,328	1,786	1,321	13,687	33,524	35,712
150.0	30	253	5,187	2,459	9,434	4,713	1,435	880	10,732	26,935	28,692
125.0	25	218	4,807	2,196	8,319	3,963	1,264	716	9,239	23,729	25,277
100.0	20	182	4,414	1,924	7,227	3,212	1,093	577	7,727	20,530	21,869
50.0	10	109	3,615	1,370	5,008	1,677	749	353	4,629	14,057	14,974

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**	**762**	**570**	**392**	**218**	**109**
TOTAL NOX (AS NO2)		G/HR	3,432	1,558	1,793	1,266	743
TOTAL CO		G/HR	469	528	298	170	202
TOTAL HC		G/HR	16	24	17	17	20
TOTAL CO2		KG/HR	357	287	186	110	65
PART MATTER		G/HR	19.6	30.6	40.7	25.0	16.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,129.1	1,257.7	2,193.7	2,567.9	2,459.9
TOTAL CO	(CORR 5% O2)	MG/NM3	301.5	410.5	362.1	354.0	751.9
TOTAL HC	(CORR 5% O2)	MG/NM3	8.8	15.9	18.0	29.7	64.2
PART MATTER	(CORR 5% O2)	MG/NM3	9.5	21.1	41.1	43.4	48.7
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	790.1	466.7	814.0	952.9	912.8
TOTAL CO	(CORR 15% O2)	MG/NM3	111.9	152.3	134.4	131.3	279.0
TOTAL HC	(CORR 15% O2)	MG/NM3	3.3	5.9	6.7	11.0	23.8
PART MATTER	(CORR 15% O2)	MG/NM3	3.5	7.8	15.3	16.1	18.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,037	613	1,068	1,251	1,198
TOTAL CO	(CORR 5% O2)	PPM	241	328	290	283	602
TOTAL HC	(CORR 5% O2)	PPM	16	30	34	55	120
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	385	227	396	464	445
TOTAL CO	(CORR 15% O2)	PPM	89	122	107	105	223
TOTAL HC	(CORR 15% O2)	PPM	6	11	12	21	44
TOTAL NOX (AS NO2)		G/HP-HR	4.58	2.76	4.60	5.83	6.82
TOTAL CO		G/HP-HR	0.63	0.93	0.76	0.78	1.85
TOTAL HC		G/HP-HR	0.02	0.04	0.04	0.08	0.19

PART MATTER	G/HP-HR	0.03	0.05	0.10	0.12	0.15
TOTAL NOX (AS NO2)	G/KW-HR	6.22	3.75	6.25	7.92	9.28
TOTAL CO	G/KW-HR	0.85	1.27	1.04	1.06	2.52
TOTAL HC	G/KW-HR	0.03	0.06	0.06	0.10	0.25
PART MATTER	G/KW-HR	0.04	0.07	0.14	0.16	0.20
TOTAL NOX (AS NO2)	LB/HR	7.57	3.43	3.95	2.79	1.64
TOTAL CO	LB/HR	1.03	1.16	0.66	0.37	0.44
TOTAL HC	LB/HR	0.04	0.05	0.04	0.04	0.05
TOTAL CO2	LB/HR	786	633	410	243	144
PART MATTER	LB/HR	0.04	0.07	0.09	0.06	0.04
OXYGEN IN EXH	%	8.3	9.6	9.4	11.4	14.3

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**	**762**	**570**	**392**	**218**	**109**
TOTAL NOX (AS NO2)		G/HR	4,153	1,885	2,170	1,532	899
TOTAL CO		G/HR	877	987	558	317	377
TOTAL HC		G/HR	30	45	33	31	39
PART MATTER		G/HR	38.1	59.8	79.3	48.8	31.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,576.3	1,521.8	2,654.4	3,107.2	2,976.4
TOTAL CO	(CORR 5% O2)	MG/NM3	563.8	767.7	677.2	661.9	1,406.0
TOTAL HC	(CORR 5% O2)	MG/NM3	16.6	30.0	34.1	56.2	121.3
PART MATTER	(CORR 5% O2)	MG/NM3	18.5	41.0	80.1	84.7	94.9
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	956.0	564.7	984.9	1,153.0	1,104.5
TOTAL CO	(CORR 15% O2)	MG/NM3	209.2	284.9	251.3	245.6	521.7
TOTAL HC	(CORR 15% O2)	MG/NM3	6.2	11.1	12.6	20.8	45.0
PART MATTER	(CORR 15% O2)	MG/NM3	6.9	15.2	29.7	31.4	35.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,255	741	1,293	1,513	1,450
TOTAL CO	(CORR 5% O2)	PPM	451	614	542	530	1,125
TOTAL HC	(CORR 5% O2)	PPM	31	56	64	105	226
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	466	275	480	562	538
TOTAL CO	(CORR 15% O2)	PPM	167	228	201	196	417
TOTAL HC	(CORR 15% O2)	PPM	12	21	24	39	84
TOTAL NOX (AS NO2)		G/HP-HR	5.54	3.33	5.56	7.05	8.25
TOTAL CO		G/HP-HR	1.17	1.75	1.43	1.46	3.46
TOTAL HC		G/HP-HR	0.04	0.08	0.08	0.14	0.35
PART MATTER		G/HP-HR	0.05	0.11	0.20	0.22	0.29
TOTAL NOX (AS NO2)		G/KW-HR	7.53	4.53	7.57	9.59	11.22
TOTAL CO		G/KW-HR	1.59	2.37	1.94	1.98	4.71
TOTAL HC		G/KW-HR	0.05	0.11	0.11	0.20	0.48
PART MATTER		G/KW-HR	0.07	0.14	0.28	0.31	0.39
TOTAL NOX (AS NO2)		LB/HR	9.15	4.16	4.78	3.38	1.98
TOTAL CO		LB/HR	1.93	2.18	1.23	0.70	0.83
TOTAL HC		LB/HR	0.07	0.10	0.07	0.07	0.09
PART MATTER		LB/HR	0.08	0.13	0.17	0.11	0.07

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	762	762	762	762	762	762	762	762	762	762	762	762	762
1,000	762	762	762	762	762	762	762	762	762	762	757	744	762
2,000	762	762	762	762	762	762	762	762	754	741	728	716	762
3,000	762	762	762	762	762	762	752	739	726	713	701	689	762
4,000	762	762	762	762	751	737	724	711	698	686	674	663	759
5,000	762	762	750	736	722	709	696	683	671	660	649	638	735
6,000	751	736	722	708	694	681	669	657	646	634	624	613	712
7,000	722	707	694	680	667	655	643	632	620	610	599	589	689
8,000	693	680	666	653	641	629	618	607	596	586	576	566	666
9,000	666	653	640	628	616	604	593	583	572	563	553	544	644
10,000	639	626	614	602	591	580	570	559	550	540	531	522	623
11,000	614	601	589	578	567	557	546	537	527	518	510	501	602
12,000	588	577	565	554	544	534	524	515	506	497	489	480	582
13,000	564	553	542	532	522	512	503	494	485	477	469	461	562
14,000	541	530	520	510	500	491	482	473	465	457	449	442	542
15,000	518	508	498	488	479	470	462	453	445	438	430	423	523

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K6281	PP5612	2864923	GS282	-	FTE02794	
0K6281	PP5612	2864924	GS282	-	FTE02794	

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

3.0 MW generators EAT02

PERFORMANCE DATA []

OCTOBER 25, 2019

For Help Desk Phone Numbers Click here

Perf No: DM9226 **Change Level:** 03

General Heat Rejection Sound Emissions Regulatory Altitude Derate Cross Reference Perf Param Ref

View PDF

SALES MODEL:	C175-16	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	4,423	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	3,000.0	**FAN POWER (HP):**	187.7
COMPRESSION RATIO:	15.3	**ASPIRATION:**	TA
RATING LEVEL:	MISSION CRITICAL STANDBY	**AFTERCOOLER TYPE:**	SCAC
PUMP QUANTITY:	2	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC+1AC, 2AC
FUEL TYPE:	DIESEL	**AFTERCOOLER TEMP (F):**	115
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	210.2
GOVERNOR TYPE:	ADEM4	**TURBO CONFIGURATION:**	PARALLEL
ELECTRONICS TYPE:	ADEM4	**TURBO QUANTITY:**	4
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	GTB6251BN-48T-1.38
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2008
INJECTOR TYPE:	CR	**CRANKCASE BLOWBY RATE (FT3/HR):**	2,436.4
FUEL INJECTOR:	4439455	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	25.1
REF EXH STACK DIAMETER (IN):	14	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,598.4

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

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
3,000.0	100	4,423	377	0.338	213.2	91.9	121.6	1,210.6	63.1	894.9
2,700.0	90	3,999	341	0.335	191.1	82.0	121.3	1,161.6	54.8	876.2
2,400.0	80	3,576	305	0.336	171.6	73.8	121.1	1,122.7	48.2	861.4
2,250.0	75	3,364	286	0.339	162.8	70.4	121.1	1,106.9	45.6	855.4
2,100.0	70	3,152	268	0.345	155.5	68.2	121.2	1,096.9	43.9	851.5
1,800.0	60	2,729	232	0.365	142.4	64.4	121.4	1,082.2	41.4	845.8
1,500.0	50	2,305	196	0.392	129.2	59.9	121.6	1,068.3	38.7	841.0
1,200.0	40	1,882	160	0.419	112.6	50.1	121.2	1,043.7	32.5	833.2
900.0	30	1,458	124	0.448	93.3	38.6	120.8	1,011.1	25.6	823.3
750.0	25	1,246	106	0.465	82.9	32.6	120.7	992.4	22.1	817.8
600.0	20	1,035	88	0.486	71.8	26.5	120.7	956.4	18.6	799.8
300.0	10	611	52	0.549	47.9	14.1	121.1	792.3	11.6	696.1

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
3,000.0	100	4,423	91	449.9	9,354.6	24,561.2	41,178.2	42,670.8	8,914.9	8,125.8
2,700.0	90	3,999	82	413.5	8,669.4	22,333.8	37,919.5	39,258.2	8,219.9	7,506.8

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
2,400.0	80	3,576	74	383.9	8,104.4	20,515.6	35,241.7	36,443.9	7,635.4	6,989.2
2,250.0	75	3,364	70	371.6	7,867.0	19,759.9	34,120.5	35,261.2	7,387.5	6,771.0
2,100.0	70	3,152	68	364.5	7,728.5	19,298.5	33,455.9	34,545.6	7,236.5	6,643.0
1,800.0	60	2,729	64	353.0	7,492.6	18,546.1	32,341.4	33,337.7	6,984.7	6,432.9
1,500.0	50	2,305	60	338.7	7,182.4	17,661.1	30,929.1	31,831.8	6,676.1	6,168.3
1,200.0	40	1,882	50	308.4	6,446.9	15,853.5	27,583.4	28,376.7	6,029.1	5,577.3
900.0	30	1,458	39	267.3	5,556.6	13,501.7	23,627.7	24,286.8	5,174.3	4,794.1
750.0	25	1,246	33	243.4	5,078.3	12,165.9	21,540.3	22,123.2	4,682.6	4,345.1
600.0	20	1,035	27	217.5	4,586.9	10,746.2	19,412.2	19,914.7	4,195.0	3,902.4
300.0	10	611	14	160.7	3,587.5	7,713.3	15,115.2	15,450.4	3,281.3	3,076.1

Heat Rejection Data Top

Note(s)
PUMP POWER IS INCLUDED IN HEAT REJECTION BALANCE, BUT IS NOT SHOWN.

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 2ND STAGE 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
3,000.0	100	4,423	78,059	10,340	177,889	98,540	24,373	27,992	187,548	457,607	487,466
2,700.0	90	3,999	69,753	9,728	158,027	87,354	21,844	22,735	169,590	410,123	436,884
2,400.0	80	3,576	62,813	9,257	142,134	78,630	19,611	18,646	151,631	368,192	392,217
2,250.0	75	3,364	59,856	9,074	135,676	75,107	18,605	17,040	142,651	349,309	372,102
2,100.0	70	3,152	57,689	8,964	131,604	72,930	17,781	16,060	133,672	333,838	355,621
1,800.0	60	2,729	54,062	8,823	125,449	69,433	16,278	14,739	115,714	305,626	325,568
1,500.0	50	2,305	50,534	8,716	119,331	65,520	14,768	13,646	97,755	277,263	295,355
1,200.0	40	1,882	45,771	8,538	108,948	57,374	12,870	11,188	79,796	241,627	257,393
900.0	30	1,458	39,630	8,265	94,183	48,019	10,669	8,349	61,838	200,308	213,378
750.0	25	1,246	36,078	8,096	85,285	43,193	9,471	7,028	52,858	177,821	189,424
600.0	20	1,035	31,984	7,842	74,947	37,306	8,207	5,910	43,879	154,087	164,142
300.0	10	611	21,612	6,922	48,843	22,014	5,475	4,318	25,920	102,790	109,497

Sound Data Top

Note(s)
SOUND DATA REPRESENTATIVE OF NOISE PRODUCED BY THE "ENGINE ONLY"

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	134.5	109.7	115.8	113.7	115.5	116.0	119.0	119.9	121.5	120.4	121.2
2,700.0	90	3,999	133.2	110.2	116.1	112.6	114.3	114.5	117.3	118.4	120.1	118.3	119.5
2,400.0	80	3,576	132.0	111.6	116.6	111.0	112.7	113.0	115.6	116.9	118.4	116.5	117.7
2,250.0	75	3,364	131.4	112.4	116.8	110.2	111.9	112.3	114.8	116.2	117.6	115.6	116.8
2,100.0	70	3,152	130.7	113.2	117.1	109.3	111.1	111.6	114.0	115.5	116.8	114.7	115.9
1,800.0	60	2,729	129.5	114.8	117.6	107.5	109.4	110.2	112.3	114.1	115.1	113.0	114.0
1,500.0	50	2,305	128.2	116.3	118.1	105.8	107.8	108.7	110.6	112.6	113.4	111.2	112.2
1,200.0	40	1,882	127.0	117.9	118.6	104.1	106.1	107.3	108.9	111.2	111.8	109.5	110.3
900.0	30	1,458	125.7	119.5	119.1	102.3	104.4	105.9	107.3	109.8	110.1	107.7	108.5
750.0	25	1,246	125.1	120.2	119.3	101.4	103.6	105.2	106.4	109.1	109.3	106.8	107.6
600.0	20	1,035	124.4	121.0	119.6	100.6	102.8	104.5	105.6	108.4	108.4	105.9	106.7
300.0	10	611	123.2	122.6	120.0	98.8	101.1	103.0	103.9	106.9	106.8	104.2	104.8

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	122.2	122.6	123.5	124.9	124.7	123.1	122.4	121.6	120.1	119.0	123.4
2,700.0	90	3,999	120.7	121.0	122.2	123.5	123.2	121.5	120.8	120.0	118.7	117.8	123.8
2,400.0	80	3,576	119.4	119.7	120.8	122.5	121.9	120.4	119.8	119.0	117.7	117.1	123.5
2,250.0	75	3,364	118.8	119.1	120.1	122.0	121.3	119.9	119.4	118.6	117.2	116.8	123.3
2,100.0	70	3,152	118.1	118.5	119.4	121.5	120.6	119.3	119.0	118.2	116.7	116.5	123.1
1,800.0	60	2,729	116.9	117.3	118.0	120.4	119.4	118.3	118.1	117.3	115.6	115.9	122.6
1,500.0	50	2,305	115.6	116.2	116.6	119.4	118.1	117.3	117.2	116.4	114.6	115.3	122.1
1,200.0	40	1,882	114.3	115.0	115.1	118.4	116.8	116.3	116.4	115.6	113.6	114.7	121.6
900.0	30	1,458	113.1	113.8	113.7	117.4	115.6	115.3	115.5	114.7	112.6	114.1	121.1
750.0	25	1,246	112.4	113.2	113.0	116.9	114.9	114.8	115.1	114.3	112.1	113.8	120.9
600.0	20	1,035	111.8	112.6	112.3	116.4	114.3	114.2	114.7	113.9	111.6	113.5	120.7
300.0	10	611	110.5	111.4	110.9	115.4	113.0	113.2	113.8	113.0	110.6	112.9	120.2

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	125.9	89.8	105.6	98.4	100.6	104.5	108.3	111.6	113.3	112.5	114.1
2,700.0	90	3,999	125.8	89.4	105.5	97.9	100.9	103.3	108.7	111.1	112.7	112.2	113.8
2,400.0	80	3,576	126.0	89.0	105.0	97.8	99.8	102.4	108.0	111.0	111.8	111.9	113.0
2,250.0	75	3,364	126.1	88.8	104.7	97.8	99.1	102.1	107.5	111.0	111.3	111.7	112.6
2,100.0	70	3,152	126.2	88.5	104.3	97.8	98.4	101.7	107.0	111.0	110.8	111.6	112.2
1,800.0	60	2,729	126.5	88.1	103.7	97.8	96.9	100.9	106.0	111.0	109.8	111.2	111.4
1,500.0	50	2,305	126.7	87.7	103.0	97.8	95.4	100.2	105.1	111.0	108.8	110.9	110.5
1,200.0	40	1,882	127.0	87.3	102.4	97.7	94.0	99.4	104.1	110.9	107.8	110.6	109.7
900.0	30	1,458	127.2	86.9	101.7	97.7	92.5	98.6	103.1	110.9	106.8	110.2	108.9
750.0	25	1,246	127.3	86.7	101.4	97.7	91.8	98.2	102.6	110.9	106.3	110.1	108.5
600.0	20	1,035	127.4	86.4	101.0	97.7	91.0	97.9	102.1	110.9	105.8	109.9	108.1
300.0	10	611	127.7	86.0	100.4	97.7	89.6	97.1	101.2	110.9	104.8	109.6	107.2

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	112.7	113.9	114.6	115.3	115.0	112.7	110.9	111.9	114.3	113.4	117.8
2,700.0	90	3,999	112.5	113.7	114.5	115.0	114.5	112.3	110.4	111.1	113.6	112.9	119.2
2,400.0	80	3,576	112.2	113.2	113.8	114.4	114.2	111.9	110.0	110.7	113.2	112.6	121.4
2,250.0	75	3,364	112.0	112.9	113.4	114.0	114.2	111.7	109.8	110.5	112.9	112.6	122.6
2,100.0	70	3,152	111.8	112.6	113.0	113.7	114.1	111.4	109.6	110.3	112.7	112.5	123.8
1,800.0	60	2,729	111.3	112.1	112.2	113.1	113.9	111.0	109.3	110.0	112.3	112.3	126.2
1,500.0	50	2,305	110.9	111.5	111.4	112.4	113.7	110.6	109.0	109.6	111.9	112.1	128.6
1,200.0	40	1,882	110.5	110.9	110.5	111.7	113.5	110.2	108.6	109.3	111.5	111.9	131.0
900.0	30	1,458	110.1	110.3	109.7	111.1	113.4	109.8	108.3	109.0	111.0	111.8	133.4
750.0	25	1,246	109.9	110.0	109.3	110.7	113.3	109.6	108.1	108.8	110.8	111.7	134.6
600.0	20	1,035	109.7	109.7	108.9	110.4	113.2	109.3	107.9	108.6	110.6	111.6	135.8
300.0	10	611	109.3	109.2	108.1	109.7	113.0	108.9	107.6	108.3	110.2	111.4	138.2

Emissions Data Top

Units Filter All Units

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN ENGINE POWER		EKW BHP	3,000.0 4,423	2,250.0 3,364	1,500.0 2,305	750.0 1,246	300.0 611
PERCENT LOAD		%	100	75	50	25	10
TOTAL NOX (AS NO2)		G/HR	32,120	21,539	9,430	3,810	3,351
TOTAL CO		G/HR	2,658	3,451	1,789	1,814	1,830
TOTAL HC		G/HR	245	185	358	385	347
PART MATTER		G/HR	160.9	170.2	122.6	134.5	129.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,723.8	3,345.5	1,874.3	1,261.1	2,241.5
TOTAL CO	(CORR 5% O2)	MG/NM3	268.6	462.8	302.2	502.2	1,002.8
TOTAL HC	(CORR 5% O2)	MG/NM3	20.9	21.5	53.3	95.7	161.8
PART MATTER	(CORR 5% O2)	MG/NM3	14.0	19.8	18.4	33.9	64.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,814	1,630	913	614	1,092

GENSET POWER WITH FAN ENGINE POWER		EKW BHP	3,000.0 4,423	2,250.0 3,364	1,500.0 2,305	750.0 1,246	300.0 611
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
TOTAL CO	(CORR 5% O2)	PPM	215	370	242	402	802
TOTAL HC	(CORR 5% O2)	PPM	39	40	100	179	302
TOTAL NOX (AS NO2)		G/HP-HR	7.29	6.42	4.09	3.05	5.47
TOTAL CO		G/HP-HR	0.60	1.03	0.78	1.45	2.99
TOTAL HC		G/HP-HR	0.06	0.06	0.16	0.31	0.57
PART MATTER		G/HP-HR	0.04	0.05	0.05	0.11	0.21
TOTAL NOX (AS NO2)		LB/HR	70.81	47.49	20.79	8.40	7.39
TOTAL CO		LB/HR	5.86	7.61	3.94	4.00	4.03
TOTAL HC		LB/HR	0.54	0.41	0.79	0.85	0.76
PART MATTER		LB/HR	0.35	0.38	0.27	0.30	0.29

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN ENGINE POWER		EKW BHP	3,000.0 4,423	2,250.0 3,364	1,500.0 2,305	750.0 1,246	300.0 611
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
TOTAL NOX (AS NO2)		G/HR	26,766	17,949	7,858	3,175	2,792
TOTAL CO		G/HR	1,477	1,917	994	1,008	1,017
TOTAL HC		G/HR	184	139	269	289	261
TOTAL CO2		KG/HR	2,236	1,651	1,287	779	428
PART MATTER		G/HR	115.0	121.5	87.6	96.1	92.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,103.2	2,787.9	1,561.9	1,050.9	1,867.9
TOTAL CO	(CORR 5% O2)	MG/NM3	149.2	257.1	167.9	279.0	557.1
TOTAL HC	(CORR 5% O2)	MG/NM3	15.7	16.2	40.1	72.0	121.7
PART MATTER	(CORR 5% O2)	MG/NM3	10.0	14.2	13.1	24.2	45.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,512	1,358	761	512	910
TOTAL CO	(CORR 5% O2)	PPM	119	206	134	223	446
TOTAL HC	(CORR 5% O2)	PPM	29	30	75	134	227
TOTAL NOX (AS NO2)		G/HP-HR	6.07	5.35	3.41	2.55	4.56
TOTAL CO		G/HP-HR	0.34	0.57	0.43	0.81	1.66
TOTAL HC		G/HP-HR	0.04	0.04	0.12	0.23	0.43
PART MATTER		G/HP-HR	0.03	0.04	0.04	0.08	0.15
TOTAL NOX (AS NO2)		LB/HR	59.01	39.57	17.32	7.00	6.16
TOTAL CO		LB/HR	3.26	4.23	2.19	2.22	2.24
TOTAL HC		LB/HR	0.41	0.31	0.59	0.64	0.57
TOTAL CO2		LB/HR	4,930	3,639	2,836	1,717	943
PART MATTER		LB/HR	0.25	0.27	0.19	0.21	0.20
OXYGEN IN EXH		%	9.6	10.2	11.6	12.7	14.5
DRY SMOKE OPACITY		%	0.7	1.0	0.3	0.8	1.8
BOSCH SMOKE NUMBER			0.25	0.36	0.13	0.29	0.62

Regulatory Information Top

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 Top

Note(s)

ALTITUDE DERATE DATA IS BASED ON THE ASSUMPTION OF A 20 DEGREES CELSIUS(36 DEGREES FAHRENHEIT) DIFFERENCE BETWEEN AMBIENT OPERATING TEMPERATURE AND ENGINE INLET MANIFOLD TEMPERATURE (IMAT). AMBIENT OPERATING TEMPERATURE IS DEFINED AS THE AIR TEMPERATURE MEASURED AT THE TURBOCHARGER COMPRESSOR INLET.

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)													

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
0	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423
1,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,405	4,423
2,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,355	4,423
3,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,376	4,309	4,216	4,423
4,000	4,345	4,345	4,345	4,345	4,345	4,345	4,344	4,344	4,343	4,280	4,190	4,100	4,345
5,000	4,174	4,174	4,174	4,174	4,174	4,174	4,173	4,172	4,170	4,130	4,073	4,017	4,174
6,000	4,015	4,015	4,015	4,015	4,015	4,015	4,013	4,011	4,008	3,988	3,960	3,933	4,015
7,000	3,868	3,868	3,868	3,868	3,868	3,868	3,866	3,863	3,859	3,853	3,847	3,840	3,868
8,000	3,751	3,751	3,751	3,751	3,751	3,751	3,749	3,745	3,742	3,736	3,729	3,723	3,751
9,000	3,634	3,634	3,634	3,634	3,634	3,634	3,633	3,628	3,624	3,618	3,612	3,606	3,634
10,000	3,523	3,523	3,523	3,523	3,523	3,523	3,521	3,517	3,512	3,506	3,500	3,495	3,523
11,000	3,417	3,417	3,417	3,417	3,417	3,417	3,415	3,411	3,406	3,400	3,394	3,388	3,417
12,000	3,312	3,312	3,312	3,312	3,312	3,312	3,310	3,304	3,299	3,294	3,288	3,282	3,312
13,000	3,206	3,206	3,206	3,206	3,206	3,206	3,204	3,198	3,193	3,188	3,182	3,176	3,206
14,000	3,100	3,100	3,100	3,100	3,100	3,100	3,098	3,093	3,088	3,083	3,079	3,074	3,100
15,000	2,993	2,993	2,993	2,993	2,993	2,993	2,991	2,988	2,984	2,981	2,977	2,974	2,993

Cross Reference Top

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
3704727	LL6307	3079788	GS265	-	WYB00620	

Performance Parameter Reference Top

Parameters Reference: DM9600 - 11

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600

APPLICATION: Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.

PERFORMANCE PARAMETER TOLERANCE FACTORS: Power +/- 3% Torque +/- 3% Exhaust stack temperature +/- 8% Inlet airflow +/- 5% Intake manifold pressure-gage +/- 10% Exhaust flow +/- 6% Specific fuel consumption +/- 3% Fuel rate +/- 5% Specific DEF consumption +/- 3% DEF rate +/- 5% Heat rejection +/- 5% Heat rejection exhaust only +/- 10% Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.

C280/3600 HEAT REJECTION TOLERANCE FACTORS: Heat rejection +/- 10% Heat rejection to Atmosphere +/- 50% Heat rejection to Lube Oil +/- 20% Heat rejection to Aftercooler +/- 5%

TEST CELL TRANSDUCER TOLERANCE FACTORS: Torque +/- 0.5% Speed +/- 0.2% Fuel flow +/- 1.0% Temperature +/- 2.0 C degrees Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.

REFERENCE ATMOSPHERIC INLET AIR FOR 3500 ENGINES AND SMALLER SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.

MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE Location for air temperature measurement air cleaner inlet at stabilized operating conditions.

REFERENCE EXHAUST STACK DIAMETER The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.

REFERENCE FUEL DIESEL Reference fuel is #2 distillate diesel with a 35API gravity; A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 29 deg C (84.2 deg F), where the density is 838.9 G/Liter (7.001 Lbs/Gal).
GAS Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.

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

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

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

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

EMISSIONS DEFINITIONS: Emissions : DM1176

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

HEAT REJECTION DEFINITIONS: Diesel Circuit Type and HHV Balance : DM9500

HIGH DISPLACEMENT (HD) DEFINITIONS: 3500: EM1500

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

SOUND DEFINITIONS: Sound Power : DM8702
Sound Pressure : TM7080

Date Released : 07/10/19

0.5 MW generator EAT02

PERFORMANCE DATA[DM8155]

September 25, 2020

Performance Number: DM8155 **Change Level: 04**

SALES MODEL:	C15	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	762	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	500.0	**FAN POWER (HP):**	33.7
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):**	120
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	192.2
GOVERNOR TYPE:	ELEC	**TURBO CONFIGURATION:**	SINGLE
CAMSHAFT TYPE:	STANDARD	**TURBO QUANTITY:**	1
IGNITION TYPE:	CI	**TURBOCHARGER MODEL:**	GTA5518BS-56T-1.58
INJECTOR TYPE:	EUI	**CERTIFICATION YEAR:**	2006
REF EXH STACK DIAMETER (IN):	6	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,025.0
MAX OPERATING ALTITUDE (FT):	3,281		

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)	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
500.0	100	762	361	0.333	35.7	68.2	120.4	1,296.3	46.8	988.0
450.0	90	683	324	0.348	33.5	67.0	119.4	1,280.7	45.9	973.8
400.0	80	607	288	0.358	30.6	61.6	115.2	1,250.1	42.3	956.6
375.0	75	570	271	0.358	28.8	56.4	111.0	1,229.5	38.8	947.8
350.0	70	534	253	0.356	26.8	50.1	106.0	1,205.6	34.6	938.3
300.0	60	462	219	0.347	22.6	36.6	95.5	1,148.6	25.6	915.7
250.0	50	392	186	0.336	18.6	24.0	86.2	1,080.0	17.4	887.9
200.0	40	323	153	0.339	15.4	16.9	83.6	1,003.8	13.3	838.1
150.0	30	253	120	0.347	12.4	11.3	81.0	910.6	10.2	768.4
125.0	25	218	103	0.355	10.9	9.1	79.8	857.1	9.0	725.6
100.0	20	182	86	0.368	9.4	7.0	78.6	795.3	8.0	674.7
50.0	10	109	52	0.420	6.5	3.3	76.2	639.0	6.1	542.9

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
500.0	100	762	73	405.8	1,347.7	3,605.5	6,001.8	6,255.3	1,224.6	1,109.4
450.0	90	683	72	402.2	1,345.2	3,558.0	5,981.4	6,219.2	1,220.4	1,110.6
400.0	80	607	66	381.3	1,283.7	3,364.8	5,686.7	5,904.2	1,168.1	1,066.0
375.0	75	570	61	361.0	1,219.4	3,187.1	5,381.2	5,585.8	1,113.3	1,016.3
350.0	70	534	54	336.1	1,139.2	2,970.6	5,001.5	5,191.7	1,044.7	953.4
300.0	60	462	40	282.1	965.5	2,500.8	4,183.5	4,344.1	894.0	815.5
250.0	50	392	27	229.6	799.0	2,040.7	3,407.8	3,539.6	744.6	679.6
200.0	40	323	19	195.0	697.8	1,729.1	2,959.9	3,069.2	655.1	600.0
150.0	30	253	13	165.5	615.8	1,447.5	2,601.3	2,689.1	579.6	534.1
125.0	25	218	11	152.7	581.8	1,317.2	2,454.7	2,532.1	546.4	505.6
100.0	20	182	9	140.6	551.1	1,190.0	2,322.2	2,389.2	515.8	479.7
50.0	10	109	5	118.5	497.4	940.2	2,088.6	2,134.4	461.1	434.6

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

PERFORMANCE DATA[DM8155]

EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
500.0	100	762	10,375	5,182	28,039	17,119	4,138	6,860	32,301	77,688	82,757
450.0	90	683	9,686	4,904	27,298	16,583	3,881	6,775	28,958	72,867	77,622
400.0	80	607	8,796	4,826	25,540	15,270	3,549	6,061	25,750	66,626	70,974
375.0	75	570	8,322	4,716	24,127	14,230	3,337	5,388	24,187	62,652	66,740
350.0	70	534	7,911	4,524	22,387	13,011	3,104	4,610	22,642	58,272	62,074
300.0	60	462	7,240	4,038	18,412	10,458	2,621	3,127	19,611	49,217	52,428
250.0	50	392	6,630	3,455	14,380	8,084	2,153	1,957	16,633	40,417	43,054
200.0	40	323	5,924	2,968	11,812	6,328	1,786	1,321	13,687	33,524	35,712
150.0	30	253	5,187	2,459	9,434	4,713	1,435	880	10,732	26,935	28,692
125.0	25	218	4,807	2,196	8,319	3,963	1,264	716	9,239	23,729	25,277
100.0	20	182	4,414	1,924	7,227	3,212	1,093	577	7,727	20,530	21,869
50.0	10	109	3,615	1,370	5,008	1,677	749	353	4,629	14,057	14,974

Emissions Data

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	762	570	392	218	109
TOTAL NOX (AS NO2)		G/HR	3,707	1,682	1,937	1,368	803
TOTAL CO		G/HR	877	987	558	317	377
TOTAL HC		G/HR	30	45	33	31	39
PART MATTER		G/HR	38.1	59.8	79.3	48.8	31.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,299.5	1,358.3	2,369.2	2,773.4	2,656.6
TOTAL CO	(CORR 5% O2)	MG/NM3	563.8	767.7	677.2	661.9	1,406.0
TOTAL HC	(CORR 5% O2)	MG/NM3	16.6	30.0	34.1	56.2	121.3
PART MATTER	(CORR 5% O2)	MG/NM3	18.5	41.0	80.1	84.7	94.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,120	662	1,154	1,351	1,294
TOTAL CO	(CORR 5% O2)	PPM	451	614	542	530	1,125
TOTAL HC	(CORR 5% O2)	PPM	31	56	64	105	226
TOTAL NOX (AS NO2)		G/HP-HR	4.94	2.98	4.97	6.30	7.37
TOTAL CO		G/HP-HR	1.17	1.75	1.43	1.46	3.46
TOTAL HC		G/HP-HR	0.04	0.08	0.08	0.14	0.35
PART MATTER		G/HP-HR	0.05	0.11	0.20	0.22	0.29
TOTAL NOX (AS NO2)		LB/HR	8.17	3.71	4.27	3.01	1.77
TOTAL CO		LB/HR	1.93	2.18	1.23	0.70	0.83
TOTAL HC		LB/HR	0.07	0.10	0.07	0.07	0.09
PART MATTER		LB/HR	0.08	0.13	0.17	0.11	0.07

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	762	570	392	218	109
TOTAL NOX (AS NO2)		G/HR	3,432	1,558	1,793	1,266	743
TOTAL CO		G/HR	469	528	298	170	202
TOTAL HC		G/HR	16	24	17	17	20
TOTAL CO2		KG/HR	357	287	186	110	65
PART MATTER		G/HR	19.6	30.6	40.7	25.0	16.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,129.1	1,257.7	2,193.7	2,567.9	2,459.9
TOTAL CO	(CORR 5% O2)	MG/NM3	301.5	410.5	362.1	354.0	751.9
TOTAL HC	(CORR 5% O2)	MG/NM3	8.8	15.9	18.0	29.7	64.2
PART MATTER	(CORR 5% O2)	MG/NM3	9.5	21.1	41.1	43.4	48.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,037	613	1,068	1,251	1,198
TOTAL CO	(CORR 5% O2)	PPM	241	328	290	283	602
TOTAL HC	(CORR 5% O2)	PPM	16	30	34	55	120
TOTAL NOX (AS NO2)		G/HP-HR	4.58	2.76	4.60	5.83	6.82
TOTAL CO		G/HP-HR	0.63	0.93	0.76	0.78	1.85
TOTAL HC		G/HP-HR	0.02	0.04	0.04	0.08	0.19
PART MATTER		G/HP-HR	0.03	0.05	0.10	0.12	0.15
TOTAL NOX (AS NO2)		LB/HR	7.57	3.43	3.95	2.79	1.64
TOTAL CO		LB/HR	1.03	1.16	0.66	0.37	0.44
TOTAL HC		LB/HR	0.04	0.05	0.04	0.04	0.05
TOTAL CO2		LB/HR	786	633	410	243	144
PART MATTER		LB/HR	0.04	0.07	0.09	0.06	0.04
OXYGEN IN EXH		%	8.3	9.6	9.4	11.4	14.3

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

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	762	762	762	762	762	762	762	762	762	762	762	762	762
1,000	762	762	762	762	762	762	762	762	762	762	757	744	762
2,000	762	762	762	762	762	762	762	762	754	741	728	716	762
3,000	762	762	762	762	762	762	752	739	726	713	701	689	762
4,000	762	762	762	762	751	737	724	711	698	686	674	663	759
5,000	762	762	750	736	722	709	696	683	671	660	649	638	735
6,000	751	736	722	708	694	681	669	657	646	634	624	613	712
7,000	722	707	693	680	667	655	643	632	620	610	599	589	689
8,000	693	680	666	653	641	629	618	607	596	586	576	566	666
9,000	666	653	640	628	616	604	593	583	572	563	553	544	644
10,000	639	627	614	602	591	580	570	559	550	540	531	522	623
11,000	614	601	589	578	567	557	547	537	527	518	509	501	602
12,000	588	577	565	555	544	534	524	515	506	497	489	481	582
13,000	564	553	542	532	522	512	503	494	485	477	469	461	562
14,000	541	530	520	510	500	491	482	473	465	457	449	442	542
15,000	518	508	498	488	479	470	462	453	445	438	430	423	523

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K6281	PP5612	2864923	GS282	-	FTE02794	
0K6281	PP5612	2864924	GS282	-	FTE02794	

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in

part or are similar to SAE J1995. Special engine rating request
(SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not
use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values
are provided for reference only, and may not meet the tolerance
listed.
These values do not apply to C280/3600. For these models, see the
tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE
AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other
engines, reference atmospheric pressure is 100 KPA (29.61 in hg),
and standard temperature is 25deg C (77 deg F) at 30% relative
humidity at the stated aftercooler water temp, or inlet manifold
temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1
and SAE J1995 JANJAN2014 reference atmospheric pressure is 100
KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F)
at 30% relative humidity and 150M altitude at the stated
aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at
stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset
is only used for the calculation of Smoke Opacity values displayed
in this dataset. This value does not necessarily represent the
actual stack diameter of the engine due to the variety of exhaust
stack adapter options available. Consult the price list, engine
order or general dimension drawings for the actual stack diameter
size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at
15 deg C (59 deg F), where the density is
850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L
(905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500
BTU/CU FT) lower heating value gas. Propane ratings are based on
87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS
EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive
standard equipment; lube oil, scavenge lube oil, fuel transfer,
common rail fuel, separate circuit aftercooler and jacket water
pumps. Engine net power available for the external (flywheel)
load is calculated by subtracting the sum of auxiliary load from
the corrected gross flywheel out put power. Typical auxiliary
loads are radiator cooling fans, hydraulic pumps, air compressors
and battery charging alternators. For Tier 4 ratings additional
Parasitic losses would also include Intake, and Exhaust
Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at
standard temperature and standard pressure at which the engine
could develop full rated output power on the current performance

data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

Used for developing DPF+SCR temperature and velocity drop

PERFORMANCE DATA[DM9226]

July 10, 2017

Performance Number: DM9226 **Change Level: 03**

SALES MODEL:	C175-16	**COMBUSTION:**	DI
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	4,423	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	3,000.0	**FAN POWER (HP):**	187.7
COMPRESSION RATIO:	15.3	**ASPIRATION:**	TA
RATING LEVEL:	MISSION CRITICAL STANDBY	**AFTERCOOLER TYPE:**	SCAC
PUMP QUANTITY:	2	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC+1AC, 2AC
FUEL TYPE:	DIESEL	**AFTERCOOLER TEMP (F):**	115
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	210.2
GOVERNOR TYPE:	ADEM4	**TURBO CONFIGURATION:**	PARALLEL
ELECTRONICS TYPE:	ADEM4	**TURBO QUANTITY:**	4
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	GTB6251BN-48T-1.38
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2008
INJECTOR TYPE:	CR	**CRANKCASE BLOWBY RATE (FT3/HR):**	2,436.4
FUEL INJECTOR:	4439455	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	25.1
REF EXH STACK DIAMETER (IN):	14	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,598.4

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

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	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
3,000.0	100	4,423	377	0.338	213.2	91.9	121.6	1,210.6	63.1	894.9
2,700.0	90	3,999	341	0.335	191.1	82.0	121.3	1,161.6	54.8	876.2
2,400.0	80	3,576	305	0.336	171.6	73.8	121.1	1,122.7	48.2	861.4
2,250.0	75	3,364	286	0.339	162.8	70.4	121.1	1,106.9	45.6	855.4
2,100.0	70	3,152	268	0.345	155.5	68.2	121.2	1,096.9	43.9	851.5
1,800.0	60	2,729	232	0.365	142.4	64.4	121.4	1,082.2	41.4	845.8
1,500.0	50	2,305	196	0.392	129.2	59.9	121.6	1,068.3	38.7	841.0
1,200.0	40	1,882	160	0.419	112.6	50.1	121.2	1,043.7	32.5	833.2
900.0	30	1,458	124	0.448	93.3	38.6	120.8	1,011.1	25.6	823.3
750.0	25	1,246	106	0.465	82.9	32.6	120.7	992.4	22.1	817.8
600.0	20	1,035	88	0.486	71.8	26.5	120.7	956.4	18.6	799.8
300.0	10	611	52	0.549	47.9	14.1	121.1	792.3	11.6	696.1

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
3,000.0	100	4,423	91	449.9	9,354.6	24,561.2	41,178.2	42,670.8	8,914.9	8,125.8
2,700.0	90	3,999	82	413.5	8,669.4	22,333.8	37,919.5	39,258.2	8,219.9	7,506.8
2,400.0	80	3,576	74	383.9	8,104.4	20,515.6	35,241.7	36,443.9	7,635.4	6,989.2
2,250.0	75	3,364	70	371.6	7,867.0	19,759.9	34,120.5	35,261.2	7,387.5	6,771.0
2,100.0	70	3,152	68	364.5	7,728.5	19,298.5	33,455.9	34,545.6	7,236.5	6,643.0
1,800.0	60	2,729	64	353.0	7,492.6	18,546.1	32,341.4	33,337.7	6,984.7	6,432.9
1,500.0	50	2,305	60	338.7	7,182.4	17,661.1	30,929.1	31,831.8	6,676.1	6,168.3
1,200.0	40	1,882	50	308.4	6,446.9	15,853.5	27,583.4	28,376.7	6,029.1	5,577.3
900.0	30	1,458	39	267.3	5,556.6	13,501.7	23,627.7	24,286.8	5,174.3	4,794.1
750.0	25	1,246	33	243.4	5,078.3	12,165.9	21,540.3	22,123.2	4,682.6	4,345.1
600.0	20	1,035	27	217.5	4,586.9	10,746.2	19,412.2	19,914.7	4,195.0	3,902.4
300.0	10	611	14	160.7	3,587.5	7,713.3	15,115.2	15,450.4	3,281.3	3,076.1

Heat Rejection Data

PUMP POWER IS INCLUDED IN HEAT REJECTION BALANCE, BUT IS NOT SHOWN.

GENSET	PERCENT	ENGINE	REJECTION	REJECTION	REJECTION	EXHUAST	FROM OIL	FROM 2ND	WORK	LOW HEAT	HIGH HEAT

PERFORMANCE DATA[DM9226]

POWER WITH FAN	LOAD	POWER	TO JACKET WATER	TO ATMOSPHERE	TO EXH	RECOVERY TO 350F	COOLER	STAGE AFTERCOOLER	ENERGY	VALUE ENERGY	VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
3,000.0	100	4,423	78,059	10,340	177,889	98,540	24,373	27,992	187,548	457,607	487,466
2,700.0	90	3,999	69,753	9,728	158,027	87,354	21,844	22,735	169,590	410,123	436,884
2,400.0	80	3,576	62,813	9,257	142,134	78,630	19,611	18,646	151,631	368,192	392,217
2,250.0	75	3,364	59,856	9,074	135,676	75,107	18,605	17,040	142,651	349,309	372,102
2,100.0	70	3,152	57,689	8,964	131,604	72,930	17,781	16,060	133,672	333,838	355,621
1,800.0	60	2,729	54,062	8,823	125,449	69,433	16,278	14,739	115,714	305,626	325,568
1,500.0	50	2,305	50,534	8,716	119,331	65,520	14,768	13,646	97,755	277,263	295,355
1,200.0	40	1,882	45,771	8,538	108,948	57,374	12,870	11,188	79,796	241,627	257,393
900.0	30	1,458	39,630	8,265	94,183	48,019	10,669	8,349	61,838	200,308	213,378
750.0	25	1,246	36,078	8,096	85,285	43,193	9,471	7,028	52,858	177,821	189,424
600.0	20	1,035	31,984	7,842	74,947	37,306	8,207	5,910	43,879	154,087	164,142
300.0	10	611	21,612	6,922	48,843	22,014	5,475	4,318	25,920	102,790	109,497

Sound Data

SOUND DATA REPRESENTATIVE OF NOISE PRODUCED BY THE "ENGINE ONLY"

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	134.5	109.7	115.8	113.7	115.5	116.0	119.0	119.9	121.5	120.4
2,700.0	90	3,999	133.2	110.2	116.1	112.6	114.3	114.5	117.3	118.4	120.1	118.3
2,400.0	80	3,576	132.0	111.6	116.6	111.0	112.7	113.0	115.6	116.9	118.4	116.5
2,250.0	75	3,364	131.4	112.4	116.8	110.2	111.9	112.3	114.8	116.2	117.6	115.6
2,100.0	70	3,152	130.7	113.2	117.1	109.3	111.1	111.6	114.0	115.5	116.8	114.7
1,800.0	60	2,729	129.5	114.8	117.6	107.5	109.4	110.2	112.3	114.1	115.1	113.0
1,500.0	50	2,305	128.2	116.3	118.1	105.8	107.8	108.7	110.6	112.6	113.4	111.2
1,200.0	40	1,882	127.0	117.9	118.6	104.1	106.1	107.3	108.9	111.2	111.8	109.5
900.0	30	1,458	125.7	119.5	119.1	102.3	104.4	105.9	107.3	109.8	110.1	107.7
750.0	25	1,246	125.1	120.2	119.3	101.4	103.6	105.2	106.4	109.1	109.3	106.8
600.0	20	1,035	124.4	121.0	119.6	100.6	102.8	104.5	105.6	108.4	108.4	105.9
300.0	10	611	123.2	122.6	120.0	98.8	101.1	103.0	103.9	106.9	106.8	104.2

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	122.2	122.6	123.5	124.9	124.7	123.1	122.4	121.6	120.1	119.0
2,700.0	90	3,999	120.7	121.0	122.2	123.5	123.2	121.5	120.8	120.0	118.7	117.8
2,400.0	80	3,576	119.4	119.7	120.8	122.5	121.9	120.4	119.8	119.0	117.7	117.1
2,250.0	75	3,364	118.8	119.1	120.1	122.0	121.3	119.9	119.4	118.6	117.2	116.8
2,100.0	70	3,152	118.1	118.5	119.4	121.5	120.6	119.3	119.0	118.2	116.7	116.5
1,800.0	60	2,729	116.9	117.3	118.0	120.4	119.4	118.3	118.1	117.3	115.6	115.9
1,500.0	50	2,305	115.6	116.2	116.6	119.4	118.1	117.3	117.2	116.4	114.6	115.3
1,200.0	40	1,882	114.3	115.0	115.1	118.4	116.8	116.3	116.4	115.6	113.6	114.7
900.0	30	1,458	113.1	113.8	113.7	117.4	115.6	115.3	115.5	114.7	112.6	114.1
750.0	25	1,246	112.4	113.2	113.0	116.9	114.9	114.8	115.1	114.3	112.1	113.8
600.0	20	1,035	111.8	112.6	112.3	116.4	114.3	114.2	114.7	113.9	111.6	113.5
300.0	10	611	110.5	111.4	110.9	115.4	113.0	113.2	113.8	113.0	110.6	112.9

Sound Data (Continued)

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	125.9	89.8	105.6	98.4	100.6	104.5	108.3	111.6	113.3	112.5
2,700.0	90	3,999	125.8	89.4	105.5	97.9	100.9	103.3	108.7	111.1	112.7	112.2
2,400.0	80	3,576	126.0	89.0	105.0	97.8	99.8	102.4	108.0	111.0	111.8	111.9
2,250.0	75	3,364	126.1	88.8	104.7	97.8	99.1	102.1	107.5	111.0	111.3	111.7

2,100.0	70	3,152	126.2	88.5	104.3	97.8	98.4	101.7	107.0	111.0	110.8	111.6
1,800.0	60	2,729	126.5	88.1	103.7	97.8	96.9	100.9	106.0	111.0	109.8	111.2
1,500.0	50	2,305	126.7	87.7	103.0	97.8	95.4	100.2	105.1	111.0	108.8	110.9
1,200.0	40	1,882	127.0	87.3	102.4	97.7	94.0	99.4	104.1	110.9	107.8	110.6
900.0	30	1,458	127.2	86.9	101.7	97.7	92.5	98.6	103.1	110.9	106.8	110.2
750.0	25	1,246	127.3	86.7	101.4	97.7	91.8	98.2	102.6	110.9	106.3	110.1
600.0	20	1,035	127.4	86.4	101.0	97.7	91.0	97.9	102.1	110.9	105.8	109.9
300.0	10	611	127.7	86.0	100.4	97.7	89.6	97.1	101.2	110.9	104.8	109.6

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,000.0	100	4,423	112.7	113.9	114.6	115.3	115.0	112.7	110.9	111.9	114.3	113.4
2,700.0	90	3,999	112.5	113.7	114.5	115.0	114.5	112.3	110.4	111.1	113.6	112.9
2,400.0	80	3,576	112.2	113.2	113.8	114.4	114.2	111.9	110.0	110.7	113.2	112.6
2,250.0	75	3,364	112.0	112.9	113.4	114.0	114.2	111.7	109.8	110.5	112.9	112.6
2,100.0	70	3,152	111.8	112.6	113.0	113.7	114.1	111.4	109.6	110.3	112.7	112.5
1,800.0	60	2,729	111.3	112.1	112.2	113.1	113.9	111.0	109.3	110.0	112.3	112.3
1,500.0	50	2,305	110.9	111.5	111.4	112.4	113.7	110.6	109.0	109.6	111.9	112.1
1,200.0	40	1,882	110.5	110.9	110.5	111.7	113.5	110.2	108.6	109.3	111.5	111.9
900.0	30	1,458	110.1	110.3	109.7	111.1	113.4	109.8	108.3	109.0	111.0	111.8
750.0	25	1,246	109.9	110.0	109.3	110.7	113.3	109.6	108.1	108.8	110.8	111.7
600.0	20	1,035	109.7	109.7	108.9	110.4	113.2	109.3	107.9	108.6	110.6	111.6
300.0	10	611	109.3	109.2	108.1	109.7	113.0	108.9	107.6	108.3	110.2	111.4

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	3,000.0	2,250.0	1,500.0	750.0	300.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	4,423	3,364	2,305	1,246	611
TOTAL NOX (AS NO2)		G/HR	32,120	21,539	9,430	3,810	3,351
TOTAL CO		G/HR	2,658	3,451	1,789	1,814	1,830
TOTAL HC		G/HR	245	185	358	385	347
PART MATTER		G/HR	160.9	170.2	122.6	134.5	129.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,723.8	3,345.5	1,874.3	1,261.1	2,241.5
TOTAL CO	(CORR 5% O2)	MG/NM3	268.6	462.8	302.2	502.2	1,002.8
TOTAL HC	(CORR 5% O2)	MG/NM3	20.9	21.5	53.3	95.7	161.8
PART MATTER	(CORR 5% O2)	MG/NM3	14.0	19.8	18.4	33.9	64.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,814	1,630	913	614	1,092
TOTAL CO	(CORR 5% O2)	PPM	215	370	242	402	802
TOTAL HC	(CORR 5% O2)	PPM	39	40	100	179	302
TOTAL NOX (AS NO2)		G/HP-HR	7.29	6.42	4.09	3.05	5.47
TOTAL CO		G/HP-HR	0.60	1.03	0.78	1.45	2.99
TOTAL HC		G/HP-HR	0.06	0.06	0.16	0.31	0.57
PART MATTER		G/HP-HR	0.04	0.05	0.05	0.11	0.21
TOTAL NOX (AS NO2)		LB/HR	70.81	47.49	20.79	8.40	7.39
TOTAL CO		LB/HR	5.86	7.61	3.94	4.00	4.03
TOTAL HC		LB/HR	0.54	0.41	0.79	0.85	0.76
PART MATTER		LB/HR	0.35	0.38	0.27	0.30	0.29

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	3,000.0	2,250.0	1,500.0	750.0	300.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	4,423	3,364	2,305	1,246	611
TOTAL NOX (AS NO2)		G/HR	26,766	17,949	7,858	3,175	2,792
TOTAL CO		G/HR	1,477	1,917	994	1,008	1,017
TOTAL HC		G/HR	184	139	269	289	261
TOTAL CO2		KG/HR	2,236	1,651	1,287	779	428
PART MATTER		G/HR	115.0	121.5	87.6	96.1	92.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,103.2	2,787.9	1,561.9	1,050.9	1,867.9
TOTAL CO	(CORR 5% O2)	MG/NM3	149.2	257.1	167.9	279.0	557.1
TOTAL HC	(CORR 5% O2)	MG/NM3	15.7	16.2	40.1	72.0	121.7
PART MATTER	(CORR 5% O2)	MG/NM3	10.0	14.2	13.1	24.2	45.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,512	1,358	761	512	910

TOTAL CO	(CORR 5% O2)	PPM	119	206	134	223	446
TOTAL HC	(CORR 5% O2)	PPM	29	30	75	134	227
TOTAL NOX (AS NO2)		G/HP-HR	6.07	5.35	3.41	2.55	4.56
TOTAL CO		G/HP-HR	0.34	0.57	0.43	0.81	1.66
TOTAL HC		G/HP-HR	0.04	0.04	0.12	0.23	0.43
PART MATTER		G/HP-HR	0.03	0.04	0.04	0.08	0.15
TOTAL NOX (AS NO2)		LB/HR	59.01	39.57	17.32	7.00	6.16
TOTAL CO		LB/HR	3.26	4.23	2.19	2.22	2.24
TOTAL HC		LB/HR	0.41	0.31	0.59	0.64	0.57
TOTAL CO2		LB/HR	4,930	3,639	2,836	1,717	943
PART MATTER		LB/HR	0.25	0.27	0.19	0.21	0.20
OXYGEN IN EXH		%	9.6	10.2	11.6	12.7	14.5
DRY SMOKE OPACITY		%	0.7	1.0	0.3	0.8	1.8
BOSCH SMOKE NUMBER			0.25	0.36	0.13	0.29	0.62

Regulatory Information

EPA TIER 2		2006 - 2010		
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 - ----		
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

ALTITUDE DERATE DATA IS BASED ON THE ASSUMPTION OF A 20 DEGREES CELSIUS(36 DEGREES FAHRENHEIT) DIFFERENCE BETWEEN AMBIENT OPERATING TEMPERATURE AND ENGINE INLET MANIFOLD TEMPERATURE (IMAT). AMBIENT OPERATING TEMPERATURE IS DEFINED AS THE AIR TEMPERATURE MEASURED AT THE TURBOCHARGER COMPRESSOR INLET.

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	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423
1,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,405	4,423
2,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,355	4,423
3,000	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,423	4,376	4,309	4,216	4,423
4,000	4,345	4,345	4,345	4,345	4,345	4,345	4,344	4,344	4,343	4,280	4,190	4,100	4,345
5,000	4,174	4,174	4,174	4,174	4,174	4,174	4,173	4,172	4,170	4,130	4,073	4,017	4,174
6,000	4,015	4,015	4,015	4,015	4,015	4,015	4,013	4,011	4,008	3,988	3,960	3,933	4,015
7,000	3,868	3,868	3,868	3,868	3,868	3,868	3,866	3,863	3,859	3,853	3,847	3,840	3,868
8,000	3,751	3,751	3,751	3,751	3,751	3,751	3,749	3,745	3,742	3,736	3,729	3,723	3,751
9,000	3,634	3,634	3,634	3,634	3,634	3,634	3,633	3,628	3,624	3,618	3,612	3,606	3,634
10,000	3,523	3,523	3,523	3,523	3,523	3,523	3,521	3,517	3,512	3,506	3,500	3,495	3,523
11,000	3,417	3,417	3,417	3,417	3,417	3,417	3,415	3,411	3,406	3,400	3,394	3,388	3,417
12,000	3,312	3,312	3,312	3,312	3,312	3,312	3,310	3,304	3,299	3,294	3,288	3,282	3,312
13,000	3,206	3,206	3,206	3,206	3,206	3,206	3,204	3,198	3,193	3,188	3,182	3,176	3,206
14,000	3,100	3,100	3,100	3,100	3,100	3,100	3,098	3,093	3,088	3,083	3,079	3,074	3,100
15,000	2,993	2,993	2,993	2,993	2,993	2,993	2,991	2,988	2,984	2,981	2,977	2,974	2,993

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
3704727	LL6307	3079788	GS265	-	WYB00620	

Performance Parameter Reference

Parameters Reference:DM9600-08

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 29 (84.2), where the density is 838.9 G/Liter (7.001 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.

EMISSIONS DEFINITIONS:

Emissions : DM1176

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 : 7/7/15

Used for developing DPF+SCR temperature and velocity drop

SOURCE TEST REPORT
2019 INITIAL COMPLIANCE TESTING
MICROSOFT MWH
3.0 MW DIESEL ENGINE
QUINCY, WASHINGTON

Prepared For:

Microsoft MWH
1515 Port Industrial Way
Quincy, WA 98848

Prepared By:

Montrose Air Quality Services, LLC
4150 B Place NW, Suite 106
Auburn, WA 98001

Document Number: **W021AS-641276-RT-328**
Test Date: **August 21, 2019**
Submittal Date: **October 8, 2019**

STAC
ACCREDITED
TO ASTM D7036 ONLY
CERT #3925.01

MONTROSE
AIR QUALITY SERVICES

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: ______________________ Date: 10/8/19

Name: Jake Womack Title: Field Project Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: ______________________ Date: 10/08/2019

Name: Dan Duncan Title: Reporting Hub Manager

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

1.0 SUMMARY OF TEST PROGRAM AND RESULTS

1.1 PROGRAM OBJECTIVES

Montrose Air Quality Services, LLC (Montrose) was contracted by Microsoft to perform a series of air emission tests at the Microsoft MWH Data Center located in Quincy, Washington. The tests were conducted to determine compliance with the source testing requirements of the Washington Department of Ecology (WDOE) Approval Order No. 18AQ-E024.

The testing was conducted by Jake Womack, Allon Kienitz and Nick Woltkamp of Montrose on August 21, 2019. Anne Reese and Robert Raymond of Vanir coordinated the testing program. The tests were conducted according to a test plan dated August 15, 2019. Montrose performed the tests to measure the following emission parameters:

- Emission Compliance:
  - CO (ppm volume dry, lb/hr, g/kWm-hr)
  - NO_x (ppm volume dry, lb/hr, g/kWm-hr)
  - NMHC (ppm volume dry, lb/hr, g/kWm-hr)
  - NH_3 (ppm volume dry, lb/hr, g/kWm-hr)
  - PM (total) as PM_{10} (gr/dscf, lb/hr, g/kWm-hr)
- O_2 and CO_2 (% volume dry) – for molecular weight calculations
- Stack volumetric flow rate (dscfm) and moisture content (% by volume)
- Visible emissions (% opacity)

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Table 1-1. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

TABLE 1-1
SUMMARY OF AVERAGE COMPLIANCE RESULTS
MICROSOFT MWH03 DATA CENTER
3.0 MW DIESEL ENGINE
AUGUST 21, 2019

Parameter	100% Load	75% Load	50% Load	25% Load	10% Load	Weighted Average	Permit Limit
Unit Data:							
Electrical Power, kWe	3,110	2,291	1,471	732	288	--	--
Mechanical Power, kWm	3,226	2,477	1,611	829	360	--	--
BHP	4,324	3,320	2,159	1,112	483	--	--
Fuel Usage, gph	201.5	154.0	126.9	74.1	27.1	--	--
Filterable PM:							
g/kWm-hr	0.005	0.004	0.005	0.036	0.010	0.01	0.03
CO Emissions:							
g/kWm-hr	0.02	0.03	0.04	0.27	0.20	0.07	3.5
NO_X Emissions:							
g/kWm-hr	0.87	0.66	0.33	0.56	2.21	0.60	0.67
NMHC Emissions:							
g/kWm-hr	0.002	0.002	0.002	0.004	0.006	0.002	0.19
NH_3 Emissions:							
lb/hr	0.19	--	--	--	--	0.19	0.95
Visible Emissions:							
maximum % opacity	0	0	0	0	5	--	--
average % opacity	0	0	0	0	1	0	5

1.2 PROJECT CONTACTS

A list of project participants is included below:

Facility Information

Source Location:	Microsoft MWH03 Data Center 1515 Port Industrial Way Quincy, WA 98848	
Project Contact:	Anne Reese	Robert Raymond
Role:	MWH03 OFCI Manager	Project Director
Company:	Vanir Construction Management	Vanir Construction Management
Telephone:	301-639-5751	206-786-7559
Email:	anne.reese@vanir.com	robert.raymond@vanir.com

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC (Montrose)	
Contact:	Carl Slimp, PE, QSTI	Kristina Schafer, QSTI
Title:	Client Project Manager	District Manager
Telephone:	815-919-0282	253-480-3801
Email:	cslimp@montrose-env.com	kschafer@montrose-env.com

Laboratory Information

Laboratory:	Desert Research Institute	Chester LabNet
City, State:	Reno, NV	Tigard, OR

1.3 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices.

2.0 SOURCE DESCRIPTION

2.1 FACILITY AND SOURCE DESCRIPTION

The Microsoft MWH03 data center is located at 1515 Port Industrial Way near Quincy, Washington. This data center uses diesel engines for emergency backup power. These engines are equipped with particulate and NO_X abatement equipment. This testing is to prove these new engines meet standards set by the Washington Department of Ecology (WDOE) in the SEPA file #102518.

2.2 SAMPLING LOCATIONS AND ACCESS

Information regarding the sampling locations is presented below:

Sample location ID:	3.0 MW Diesel Engine Exhaust
Configuration:	Cylindrical, vertical
Dimensions:	28 inches internal diameter
Port locations:	Appx. 28 ft. (~12 duct diameters) upstream from the stack exit Appx. 4.7 ft. (~2 duct diameters) downstream from nearest stack disturbance
Port access:	Scissor lift

Traverse point information is presented below:

- Particulate tests – single point located near center of duct
- Gaseous emission tests – stratification test and sampling point selection performed per EPA Method 7E

2.3 OPERATING CONDITIONS AND PROCESS DATA

Emission tests were performed while the source/units and air pollution control devices were operating at the conditions required by the permit. The units were tested when operating within 2% of the following target load values:

- 100% load
- 75% load
- 50% load
- 25% load
- 10% load

Plant personnel established the test conditions and collected all applicable unit-operating data. Montrose monitored the collection of process data and provided additional data collection as necessary to document operation. Data collected includes the following parameters:

- Engine brake mechanical output (kWm)
- Genset power (ekW)

- Percent Load
- Engine power (bhp)
- Fuel consumption (gal/hr)
- Fuel composition, laboratory analysis
- Temperature of fuel feed and fuel return (°F)
- Exhaust manifold pressure (in. Hg)
- Production rate
- Ambient temperature, barometric pressure, and relative/absolute humidity

3.0 TEST METHOD DETAILS

3.1 LIST OF TEST METHODS

The test procedures for this test program are summarized in Table 3-1 below. Additional information regarding specific applications or modifications to standard procedures is presented in the following sub-sections.

TABLE 3-1
TEST PROCEDURES

Parameter	Measurement Principle	Reference Method
Volumetric flow rate	Stoichiometric calculation	EPA 19
O_2	Paramagnetism	40 CFR 1065 / EPA 3A
CO_2	Non-dispersive infrared	40 CFR 1065 / EPA 3A
NO_x	Chemiluminescence	40 CFR 1065 / EPA 7E
CO	Gas filter correlation NDIR	40 CFR 1065 / EPA 10
NMHC	Flame ionization detection with methane cutter	40 CFR 1065 / EPA 25A
Moisture	Impinger weight gain	EPA 4
Particulate matter	Gravimetry	40 CFR 1065
Visible emissions	Visual observation	EPA 9
Ammonia	Ion chromatography	BAAQMD ST-1B

3.1.1 EPA Method 19 – Volumetric Flow Rate

Stack gas volumetric flow rates were determined by the procedures outlined in EPA Method 19. This is a stoichiometric calculation of exhaust gas flow rate based on fuel compositional analysis (provided by Vanir), measured fuel firing rate (provided by Vanir), and measured exhaust gas carbon dioxide concentration. The fuel firing rate is measured using positive displacement fuel meters (fuel feed and return lines). Fuel meter readings were provided by Vanir.

3.1.2 Alternative EPA Method 2 Thermocouple Calibration Procedure (ALT-011)

Approved Alternative Method 011 (ALT-011) is used as an alternative to the EPA Method 2 two-point thermocouple calibration. This procedure involves a single-point in-field check using a reference thermometer to confirm that the thermocouple system is operating properly. The temperatures of the thermocouple and reference thermometers shall agree to within ±2 °F.

3.1.3 Gaseous Emissions

Concentrations of the gaseous constituents of stack gas (O_2, CO_2, NO_X & CO) are measured using Montrose's dry extractive reference method (RM) monitor system in accordance with EPA Method 7E. This system meets the requirements of EPA methods for gaseous species. Pertinent information regarding the performance of the method is presented below:

- Method Deviations: None
- Method Options: N/A
- Detection Limits: 2% of calibration span

Sampling traverse points for gaseous emissions were determined in accordance with EPA Method 7E.

3.1.4 Non-Methane Hydrocarbons

Concentrations of NMHCs were measured using Montrose's wet extractive RM monitor system in accordance with EPA method 25A. Pertinent information regarding the performance of this method is presented below:

- Method Deviations: None
- Method Options: An FID equipped with a non-methane cutter was used for measuring NMHC. The analyzer was included in the same system as the dry extractive system, but was placed so that it measures a wet sample. This instrument was calibrated on a propane basis, and checked with one methane standard gas.

3.1.5 Particulate Matter Emissions

Sampling and analysis for PM emissions was conducted according to 40 CFR Part 1065. The sampling system comprised a partial-flow dilution (PFD) system as described in 1065.140 (d).

Sample was drawn from a "Method 5" type nozzle and probe inserted to near the stack midpoint directly into a Dilution Tunnel. Dry, filtered dilution air was delivered into the mixing section of the system through a 2-inch diameter hose by a blower. Diluted sample exhaust was drawn from the other end of the system through an exhaust filter and another 2-inch diameter hose by an exhaust blower. The blower flow rates were adjusted to induce flow of stack gas through the probe into the system's dilution tunnel (i.e. exhaust flow slightly higher than dilution air flow). Calibrated venturi meters provided measurement of the flow of dilution air and the flow of undiluted sample flowing through the sampling probe into the system.

Two filter cassettes were connected to the dilution tunnel just upstream from the main exhaust filter. Diluted sample was drawn from the system through these duplicate filter cassettes during each 15-minute test run. The cassette filters were recovered after each test run, and were sent to the laboratory at the Desert Research Institute in Reno, Nevada, for analysis.

The cassette filters were the same as those used at ambient air sampling stations. The analysis of filter tare weights and final weights was conducted according to the protocol used for ambient air samples. The filter type and the analysis protocol are identical to that described in 40 CFR Part 1065, and is capable of weights to the nearest microgram.

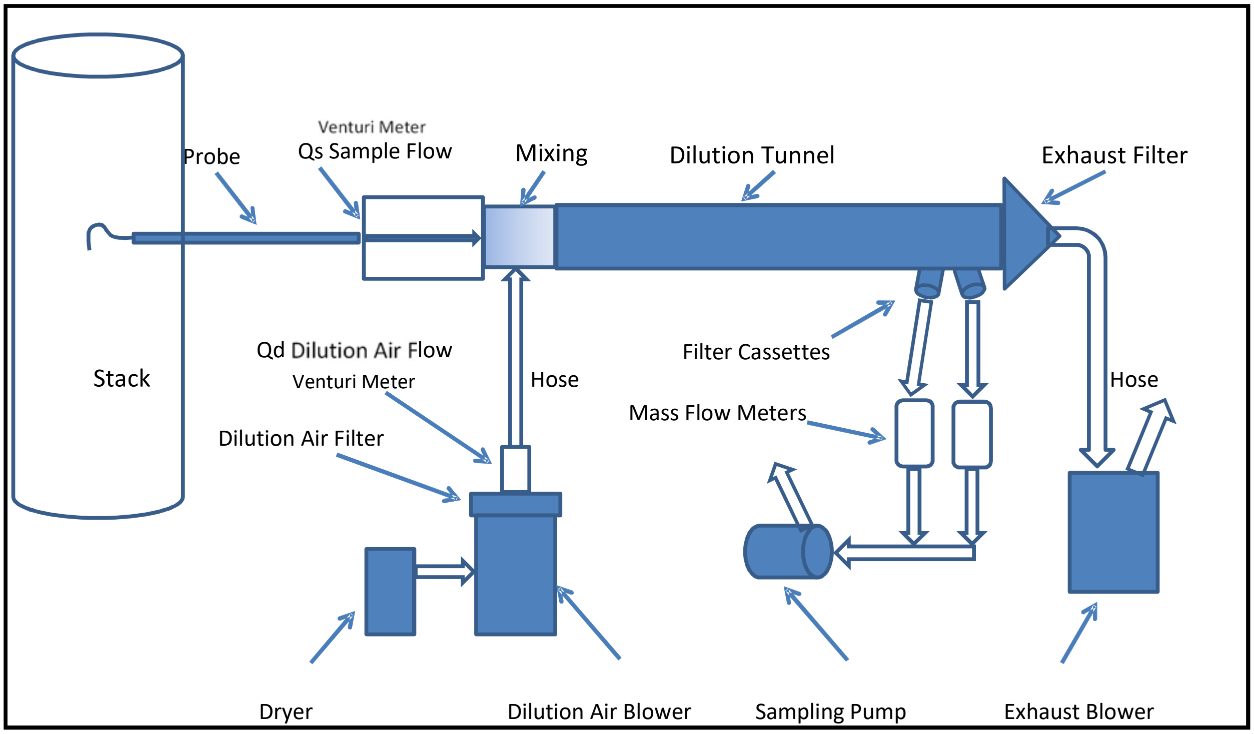

Figure 1. Partial-flow Dilution System for PM Sampling

The mass of PM collected on each filter cassette was used to calculate the stack gas concentration of PM. The measured flow rates and sampling times were used to calculate the following volumes:

- V_{C1} and V_{C2} = the volume of diluted sample drawn through each cassette (measured by calibrated mass flow meters)
- V_{ds} = the total volume of diluted sample = $V_d + V_s$
- V_d and V_s = the volumes of dilution air and undiluted sample (measured by calibrated venturi differential pressure meters)

3.1.6 Ammonia Slip

Concentrations of ammonia slip were determined using Bay Area Air Quality Management District (BAAQMD) Method ST-1B. Pertinent information regarding the performance of the methods is presented below:

- Method Deviations: Ion chromatography was used for analysis instead of ion selective electrode
- Method Options: NA
- Target Sample Duration: 30 minutes
- Other: Sample rate is not to exceed 0.75 cfm

- Analytical Laboratory: Chester LabNet – Tigard, OR

3.1.7 Visible Emissions

EPA Method 9 requires that a qualified observer shall use the following procedures for visually determining the opacity. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. The opacity observer shall be recording to the nearest five percent at 15-second intervals on an observational record sheet. A minimum of 24 observations shall be recorded per test run. Each momentary observation shall be deemed to represent the average opacity for a 15-second period. Alan Jensen is certified to read opacity and performed one six-minute test run at each load for visible emissions per EPA Method 9.

4.0 TEST RESULTS AND OVERVIEW

4.1 DISCUSSION OF RESULTS

The average results are compared to the permit limits in Table 1-1. The results of individual compliance test runs are presented in Tables 4-1 through 4-5. The test results show that all of the emissions were within their respective permit compliance limits. Emissions have been reported in units consistent with those in the permits.

Additional information is included in the appendices. Appendix A presents the general and specific equations used for the emissions calculations and computer spreadsheets. Raw field data sheets and data acquisition printouts are included in Appendix B. Laboratory reports and chain of custody sheets for the samples are located in Appendix C. CEM and process data provided by the facility is located in Appendix D. Appendix E presents the quality assurance information, including instrument calibration data. Additional correspondence and relevant regulatory information are located in Appendix F.

4.2 DEVIATIONS AND EXCEPTIONS

A second run was performed at the 50% load because the data for the first run was lost when new data was accidentally saved with the same file name.

A second run was performed at the 10% load because the NOx concentration exceeded the instrument range during the first run due to a spike halfway through the run. The analyzer was recalibrated at a higher range before the second run. A third run at the 10% load was also requested, and data from this run is presented in this report.

Incorrect cylinder identification numbers were entered into the data acquisition software. The proper ID numbers have been added to the configuration printouts in Appendix E3.

TABLE 4-1
40 CFR PART 89, 5-LOAD WEIGHTED AVERAGE RESULTS

Project Information

Client / Facility	Vanir / Microsoft MWH
Source / Location	3.0 MW Diesel Engine
Date	8/21/2019
Project No.	021AS-641276

Load		Power Rate		PM		CO		NO_X		NMHC		PM	CO	NO_X	NMHC	kWm-hr/hr
(% of max)	Run No.	kWm-hr/hr		lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	gr/hr · WF	gr/hr · WF	gr/hr · WF	gr/hr · WF	· WF
100	100-1	3,226		0.0335	0.005	0.141	0.020	6.27	0.88	0.0155	0.002	0.8	3.2	142.2	0.4	161.3
40 CFR 89 WF					0.05		0.05		0.05		0.05					
75	75-1	2,477		0.0219	0.004	0.175	0.032	3.59	0.66	0.0099	0.002	2.5	19.9	407.2	1.1	619.2
40 CFR 89 WF					0.25		0.25		0.25		0.25					
50	50-1	1,611		0.0168	0.005	0.127	0.036	1.17	0.33	0.0067	0.002	2.3	17.3	158.7	0.9	483.2
40 CFR 89 WF					0.30		0.30		0.30		0.30					
25	25-1	829		0.0660	0.036	0.494	0.270	1.02	0.56	0.0082	0.004	9.0	67.2	139.2	1.1	248.8
40 CFR 89 WF					0.30		0.30		0.30		0.30					
10	10-1	360		0.0077	0.010	0.161	0.203	1.76	2.21	0.0044	0.006	0.3	7.3	79.7	0.2	36.0
40 CFR 89 WF					0.10		0.10		0.10		0.10					

Sum PM gr/hr · WF	Sum CO gr/hr · WF	Sum NO_X gr/hr · WF	Sum NMHC gr/hr · WF	Sum kWm-hr/hr · WF
14.9	114.9	927.0	3.7	1,548.5
0.01	0.07	0.60	0.0	

	PM g/kWm-hr	**CO g/kWm-hr**	**NO_X g/kWm-hr**	**NMHC g/kWm-hr**
Measured 5-Load Weighted Average (g/kWm-hr)	**0.01**	**0.07**	**0.60**	**0.002**
Permit Limit (g/kWm-hr)	**0.03**	**3.5**	**0.67**	**0.19**

TABLE 4-2
RESULTS SUMMARY PARTICULATE MATTER EMISSIONS
MICROSOFT MWH
3.0MW DIESEL ENGINE

Load:	**100%**	**75%**	**50%**	**25%**	**10%**
Date:	8/21/2019	8/21/2019	8/21/2019	8/21/2019	8/21/2019
Time:	1010-1025	1110-1125	1548-1603	1304-1319	1640-1655
Process Data:					
Electrical Power Output, kWe	3,110	2,291	1,471	732	288
Mechanical Power Output, kWm	3,226	2,477	1,611	829	360
BHP	4,324	3,320	2,159	1,112	483
Fuel Usage, gph	201.5	154.0	126.9	74.1	27.1
Heat input, MMBtu/hr	27.81	21.25	17.51	10.23	3.75
Flue Gas:					
O_2, % volume dry	10.3	11.1	12.3	13.0	15.6
CO_2, % volume dry	7.4	7.0	6.3	5.9	4.8
Flue gas temperature °F	806	745	752	805	761
Moisture content, % volume	7.6	7.1	6.3	5.9	4.3
Volumetric flow rate, dscfm	8,367	7,873	7,070	5,901	2,249
Cassette 1 Particulate:					
Concentration, µg/dscm	1,005	534	636	2,993	879
Mass Emissions, lb/hr	0.0315	0.0158	0.0168	0.0662	0.0074
Mass Emissions, g/kWm-hr	0.0044	0.0029	0.0047	0.0362	0.0093
Cassette 2 Particulate:					
Concentration, µg/dscm	1,132	950	634	2,977	951
Mass Emissions, lb/hr	0.0355	0.0280	0.0168	0.0658	0.0080
Mass Emissions, g/kWm-hr	0.0049	0.0051	0.0047	0.0360	0.0101
Average Particulate:					
Concentration, µg/dscm	1,069	742	635	2,985	915
Mass Emissions, lb/hr	0.0335	0.0219	0.0168	0.0660	0.0770
Mass Emissions, g/kWm-hr	0.0047	0.0040	0.0047	0.0361	0.0097

TABLE 4-3
RESULTS SUMMARY GASEOUS EMISSIONS
MICROSOFT MWH
3.0MW DIESEL ENGINE

Load:	**100%**	**75%**	**50%**	**25%**	**10%**
Date:	8/21/2019	8/21/2019	8/21/2019	8/21/2019	8/21/2019
Time:	1009-1039	1110-1125	1548-1603	1304-1319	1640-1655
Process Data:					
Electrical Power Output, kWe	3,110	2,291	1,471	732	288
Mechanical Power Output, kWm	3,226	2,477	1,611	829	360
BHP	4,324	3,320	2,159	1,112	483
Fuel Usage, gph	201.5	154.0	126.9	74.1	27.1
Heat Input, MMBtu/hr	27.81	21.25	17.51	10.23	3.75
Flue Gas:					
O_2, % volume dry	10.3	11.1	12.3	13.0	15.6
CO_2, % volume dry	7.4	7.0	6.3	5.9	4.8
Flue gas temperature °F	806	745	752	805	761
Moisture content, % volume	7.6	7.1	6.3	5.9	4.3
Volumetric flow rate, dscfm	8,367	7,873	7,070	5,901	2,249
CO Emissions:					
ppm volume dry	3.9	5.1	4.1	19.2	16.5
lb/hr	0.14	0.18	0.13	0.49	0.16
NO_X Emissions:					
ppm volume dry	104.6	63.7	23.0	24.2	109.0
lb/hr	6.3	3.6	1.2	1.0	1.8
NMHC Emissions:					
ppm volume dry	0.27	0.18	0.14	0.20	0.28
lb/hr	0.016	0.0099	0.0067	0.0082	0.0044

TABLE 4-4
RESULTS SUMMARY AMMONIA EMISSIONS
MICROSOFT MWH
3.0MW DIESEL ENGINE

Run:	**1**	**2**	**3**	**Average**
Date:	8/21/2019	8/21/2019	8/21/2019	--
Time:	0821-0851	0923-0953	1009-1039	--
Process Data:				
Electrical Power Output, kWe	3,110	3,110	3,110	3,110
Mechanical Power Output, kWm	3,226	3,226	3,226	3,226
BHP	4,324	4,324	4,324	4,324
Fuel Usage, gph	201.5	201.5	201.5	201.5
Heat Input, MMBtu/hr	27.81	27.81	27.81	27.81
Flue Gas:				
O_2, % volume dry	10.6	11.7	10.3	10.9
CO_2, % volume dry	7.7	7.5	7.4	7.5
Flue gas temperature °F	806	806	806	806
Moisture content, % volume	10.6	8.8	4.4	7.9
Volumetric flow rate, dscfm	8,367	8,367	8,367	8,367
NH_3 Emissions:				
ppm volume dry	9.7	15.2	0.43	8.4
lb/hr	0.215	0.337	0.0095	0.187

**TABLE 4-5
RESULTS SUMMARY VISIBLE EMISSIONS
MICROSOFT MWH
3.0MW DIESEL ENGINE**

Load:	**100%**	**75%**	**50%**	**25%**	**10%**
Date:	8/21/2019	8/21/2019	8/21/2019	8/21/2019	8/21/2019
Time:	0944-0950	1112-1118	1550-1556	1309-1315	1646-1652
Visible Emissions:					
Maximum % opacity	0	0	0	0	5
Average % opacity	0	0	0	0	1

Appendix A.1
Gaseous Emissions Spreadsheets

SOURCE TEST DATA SUMMARY

Client	Vanir
Unit / Location	3.0 MW Diesel Engine
A (stack area), ft^2	4.276
Reference temperature, °F	68

	Test number	100%	75%	50%	25%	10%
	Date	8/21/2019	8/21/2019	8/21/2019	8/21/2019	8/21/2019
	Start / Stop time	1009-1039	1110-1125	1548-1603	1304-1319	1640-1655
	PLANT DATA					
	Engine load, kWhr/hr	3,226	2,477	1,611	829	360
	ANALYZER DATA					
	O_2, % volume dry	10.26	11.05	12.26	12.97	15.57
	CO_2, % volume dry	7.40	6.95	6.33	5.87	4.80
	CO emissions, ppm volume dry	3.86	5.10	4.11	19.20	16.46
	NO emissions, ppm volume dry	97.32	57.56	20.22	21.32	37.28
	NO_X emissions, ppm volume dry	104.60	63.67	23.02	24.20	109.00
	NHMC emissions, ppm volume wet	0.250	0.170	0.13	0.19	0.27
	VOLUMETRIC FLOW RATE					
1c	B_{ws} (moisture fraction), non-dimensional	0.0755	0.0707	0.0633	0.0590	0.0425
1j	Stack flow rate - based on fuel, dscfm	8,367	7,873	7,070	5,901	2,249
	EMISSIONS					
	CO concentrations, ppm volume dry	3.86	5.10	4.11	19.20	16.46
2e	CO mass emissions, lb/hr	0.141	0.175	0.127	0.494	0.161
	NO_X concentrations, ppm volume dry	104.6	63.67	23.02	24.20	109.0
2e	NO_X mass emissions, lb/hr as NO_2	6.27	3.59	1.17	1.02	1.76
	NMHC concentrations as propane, ppm volume dry	0.27	0.18	0.14	0.20	0.28
2e	NMHC mass emissions as propane, lb/hr	0.0155	0.0099	0.0067	0.0082	0.0044

Appendix A.3
Particulate Matter Spreadsheets

40 CFR PART 89, 5-LOAD WEIGHTED AVERAGE RESULTS

Project Information

Client / Facility	Vanir / Microsoft MWH
Source / Location	3.0 MW Diesel Engine
Date	8/21/2019
Project No.	021AS-641276

Load		Power Rate		PM		CO		NO_X		NMHC		PM	CO	NO_X	NMHC	kWm-hr/hr
(% of max)	Run No.	kWm-hr/hr		lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	lb/hr	g/kWm-hr	gr/hr · WF	gr/hr · WF	gr/hr · WF	gr/hr · WF	· WF
100	100-1	3,226		0.0335	0.005	0.141	0.020	6.27	0.88	0.0155	0.002	0.8	3.2	142.2	0.4	161.3
40 CFR 89 WF					0.05		0.05		0.05		0.05					
75	75-1	2,477		0.0219	0.004	0.175	0.032	3.59	0.66	0.0099	0.002	2.5	19.9	407.2	1.1	619.2
40 CFR 89 WF					0.25		0.25		0.25		0.25					
50	50-1	1,611		0.0168	0.005	0.127	0.036	1.17	0.33	0.0067	0.002	2.3	17.3	158.7	0.9	483.2
40 CFR 89 WF					0.30		0.30		0.30		0.30					
25	25-1	829		0.0660	0.036	0.494	0.270	1.02	0.56	0.0082	0.004	9.0	67.2	139.2	1.1	248.8
40 CFR 89 WF					0.30		0.30		0.30		0.30					
10	10-1	360		0.0077	0.010	0.161	0.203	1.76	2.21	0.0044	0.006	0.3	7.3	79.7	0.2	36.0
40 CFR 89 WF					0.10		0.10		0.10		0.10					

Sum PM gr/hr · WF	Sum CO gr/hr · WF	Sum NO_X gr/hr · WF	Sum NMHC gr/hr · WF	Sum kWm-hr/hr · WF
14.9	114.9	927.0	3.7	1,548.5
0.01	0.07	0.60	0.0	

	PM g/kWm-hr	**CO g/kWm-hr**	**NO_X g/kWm-hr**	**NMHC g/kWm-hr**
Measured 5-Load Weighted Average (g/kWm-hr)	**0.01**	**0.07**	**0.60**	**0.002**
Permit Limit (g/kWm-hr)	**0.03**	**3.5**	**0.67**	**0.19**

Particulate Matter Result Average From Part 1065 Tests

Test No:	100%	75%	50%	25%	10%
Date:	8/21/2019	7/31/2019	8/21/2019	8/21/2019	8/21/2019
Time:	1010-1025	1110-1125	1548-1603	1304-1319	1640-1655
O_2, % volume dry:	10.26	11.05	12.26	12.97	15.57
CO_2, % volume dry:	7.40	6.95	6.33	5.87	4.80
Fo	1.45	1.42	1.37	1.36	1.12
Moisture Content, % by volume: (THEORY)	7.55	7.07	6.33	5.90	4.25
Stack Temperature, °F:	806	745	752	805	761
Stack flow rate (calc from fuel flow), dscfm:	8,367	7,873	7,070	5,901	2,249
Fuel flow, gal/hr:	201.52	153.99	126.92	74.13	27.14
Fuel heat input, MMBtu/hr:	27.81	21.25	17.51	10.23	3.75
Brake hourse power, BHP	4324	3320	2159	1112	483
Load, kWe	3,109.9	2,291.0	1,471.4	732.0	288.1
Motor Power, kWm:	3,226.0	2,476.8	1,610.7	829.3	360.4
Cassette #1 PM concentrations, µg/dscm..................	1,005	534	636	2,993	879
Cassette #1 PM mass emissions, gr/dscf....................	0.0004	0.0002	0.0003	0.0013	0.0004
Cassette #1 PM mass emissions, lb/hr.......................	0.0315	0.0158	0.0168	0.0662	0.0074
Cassette #1 PM mass emissions, lb/MMBtu.............	0.0011	0.0007	0.0010	0.0065	0.0020
Cassette #1 PM mass emissions,g/kW-hr..................	0.0044	0.0029	0.0047	0.0362	0.0093
Cassette #2 PM concentrations, µg/dscm..................	1,132	950	634	2,977	951
Cassette #2 PM mass emissions, gr/dscf....................	0.0005	0.0004	0.0003	0.0013	0.0004
Cassette #2 PM mass emissions, lb/hr.......................	0.0355	0.0280	0.0168	0.0658	0.0080
Cassette #2 PM mass emissions, lb/MMBtu.............	0.0013	0.0013	0.0010	0.0064	0.0021
Cassette #2 PM mass emissions, g/kW-hr................	0.0050	0.0051	0.0047	0.0360	0.0101
Average PM concentrations, µg/dscm.......................	1,069	742	635	2,985	915
Average PM mass emissions, gr/dscf........................	0.0005	0.0003	0.0003	0.0013	0.0004
Average PM mass emissions, lb/hr............................	0.0335	0.0219	0.0168	0.0660	0.0077
Average PM mass emissions, lb/MMBtu..................	0.0012	0.0010	0.0010	0.0064	0.0021
Average PM mass emissions, g/kW-hr......................	0.0047	0.0040	0.0047	0.0361	0.0097

Note: At 100% load, kWm=eKW/0.964; kWm=(1.0567 x eKW) + 55.892 for all other loads

SOURCE TEST DATA SUMMARY

Client	Microsoft MWH	*	Test number	100%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1010-1025

Meter box ID	1538A/1527B	*	Barometric pressure, in Hg	28.60
Reference temperature, °F	68	*	Total undiluted sample volume, dscf	8.405
Stack area, square feet	4.276	*	Dilution ratio	17.551
Sample cassette flow cal factor (MF-Mix 1)	1.021	*	Sample cassette 1 flow, L/min (MF-Mix 1)	36.453
Sample cassette 2 cal factor (MF-Mix 2)	1.023	*	Sample cassette 2 flow, L/min (MF-Mix 2)	37.568
Sample time, minutes	14.92	*	142mm Filter temperature, °F	109.1
Pitot coefficient	0.8400	*	Sample venturi (Delta H), iwg	0.774
Nozzle diameter, in	0.213	*	Pitot (Delta P)	1.383
Fuel type	Diesel	*	Stack static pressure, iwg	-0.2665
Fuel "HHV", Btu/gal	138,000	*	Stack temperature, °F	806.4
Fuel "F" factor (@ T_{ref}), dscf/MMBtu	9,190	*	Stack O_2, % volume dry	**10.260**
Fuel flow rate,gal/hr	201.52	*	Stack CO_2, % volume dry	**7.395**
Cassette 1 Filter ID	MEGPT 634		Cassette 2 Filter ID	MEGPT 627

Sample filter cassette 1, µg	31
Sample filter cassette 2, µg	36

TEST RUN RESULTS SUMMARY

Client	Microsoft MWH	*	Test number	100%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1010-1025

Standard sample volume (Vs, undiluted sample), dscm	0.2380
Standard sample volume (Vds, diluted sample), dscm	4.1778
Standard sample volume (Vc1, sample filter cassette 1), dscm	0.5414
Standard sample volume (Vc2, sample filter cassette 2), dscm	0.5580
Moisture content, %	7.55
Stack gas molecular weight, wet	28.719
Stack gas molecular weight, dry	29.594
Absolute stack pressure, in Hg	28.580
Stack gas velocity, ft/sec	104.741
Stack flow rate, acfm	26,872
Stack flow rate, wscfm	10,702
Stack flow rate, dscfm	9,895
Stack flow rate (calculated from plant fuel flow), dscfm	8,367
Isokinetic ratio, %	98.88
Sample filter cassette 1 in-stack PM concentration, µg/dscm	1005
Sample filter cassette 1 grain loading, grains/dscf	4.39E-04
Sample filter cassette 1 mass emissions, lb/hr	3.15E-02
Sample filter cassette 1 mass emissions, lb/MMBtu	1.13E-03
Sample filter cassette 2 in-stack PM concentration, µg/dscm	1132
Sample filter cassette 2 grain loading, gr/dscf	4.95E-04
Sample filter cassette 2 mass emissions, lb/hr	3.55E-02
Sample filter cassette 2 mass emissions, lb/MMBtu	1.28E-03
AVERAGE	
Sample filter in-stack PM concentration, µg/dscm	1069
Sample filter grain loading, gr/dscf	4.67E-04
Sample filter mass emissions, lb/hr	3.35E-02
Sample filter mass emissions, lb/MMBtu	1.20E-03
Average Diff	5.8%

SOURCE TEST DATA SUMMARY

Client	Microsoft MWH	*	Test number	75%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1110-1125

Meter box ID	1538A/1527B	*	Barometric pressure, in Hg	27.42
Reference temperature, °F	68	*	Total undiluted sample volume, dscf	7.140
Stack area, square feet	4.276	*	Dilution ratio	20.219
Sample cassette flow cal factor (MF-Mix 1)	1.021	*	Sample cassette 1 flow, L/min (MF-Mix 1)	38.173
Sample cassette 2 cal factor (MF-Mix 2)	1.023	*	Sample cassette 2 flow, L/min (MF-Mix 2)	38.669
Sample time, minutes	14.92	*	142mm Filter temperature, °F	109.6
Pitot coefficient	0.8400	*	Sample venturi (Delta H), iwg	0.535
Nozzle diameter, in	0.213	*	Pitot (Delta P)	0.942
Fuel type	Diesel	*	Stack static pressure, iwg	-0.1827
Fuel "HHV", Btu/gal	138,000	*	Stack temperature, °F	744.9
Fuel "F" factor (@ T_{ref}), dscf/MMBtu	9,190	*	Stack O_2, % volume dry	**12.260**
Fuel flow rate,gal/hr	153.99	*	Stack CO_2, % volume dry	**6.333**
Cassette 1 Filter ID	MEGPT 614		Cassette 2 Filter ID	MEGPT 613

Sample filter cassette 1, µg	15
Sample filter cassette 2, µg	27

TEST RUN RESULTS SUMMARY

Client	Microsoft MWH	*	Test number	75%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1110-1125

Standard sample volume (Vs, undiluted sample), dscm	0.2022
Standard sample volume (Vds, diluted sample), dscm	4.0886
Standard sample volume (Vc1, sample filter cassette 1), dscm	0.5675
Standard sample volume (Vc2, sample filter cassette 2), dscm	0.5749
Moisture content, %	7.07
Stack gas molecular weight, wet	28.690
Stack gas molecular weight, dry	29.504
Absolute stack pressure, in Hg	27.406
Stack gas velocity, ft/sec	86.117
Stack flow rate, acfm	22,094
Stack flow rate, wscfm	8,869
Stack flow rate, dscfm	8,241
Stack flow rate (calculated from plant fuel flow), dscfm	7,873
Isokinetic ratio, %	100.86
Sample filter cassette 1 in-stack PM concentration, µg/dscm	534
Sample filter cassette 1 grain loading, grains/dscf	2.34E-04
Sample filter cassette 1 mass emissions, lb/hr	1.58E-02
Sample filter cassette 1 mass emissions, lb/MMBtu	7.42E-04
Sample filter cassette 2 in-stack PM concentration, µg/dscm	950
Sample filter cassette 2 grain loading, gr/dscf	4.15E-04
Sample filter cassette 2 mass emissions, lb/hr	2.80E-02
Sample filter cassette 2 mass emissions, lb/MMBtu	1.32E-03
AVERAGE	
Sample filter in-stack PM concentration, µg/dscm	742
Sample filter grain loading, gr/dscf	3.24E-04
Sample filter mass emissions, lb/hr	2.19E-02
Sample filter mass emissions, lb/MMBtu	1.03E-03
Average Diff	24.5%

SOURCE TEST DATA SUMMARY

Client	Microsoft MWH	*	Test number	50%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1548-1603

Meter box ID	1538A/1527B	*	Barometric pressure, in Hg	28.60
Reference temperature, °F	68	*	Total undiluted sample volume, dscf	16.935
Stack area, square feet	4.276	*	Dilution ratio	10.071
Sample cassette flow cal factor (MF-Mix 1)	1.021	*	Sample cassette 1 flow, L/min (MF-Mix 1)	39.522
Sample cassette 2 cal factor (MF-Mix 2)	1.023	*	Sample cassette 2 flow, L/min (MF-Mix 2)	40.704
Sample time, minutes	14.93	*	142mm Filter temperature, °F	112.2
Pitot coefficient	0.8400	*	Sample venturi (Delta H), iwg	3.496
Nozzle diameter, in	0.307	*	Pitot (Delta P)	0.661
Fuel type	Diesel	*	Stack static pressure, iwg	-0.0926
Fuel "HHV", Btu/gal	138,000	*	Stack temperature, °F	752.4
Fuel "F" factor (@ T_{ref}), dscf/MMBtu	9,190	*	Stack O_2, % volume dry	**12.970**
Fuel flow rate,gal/hr	126.92	*	Stack CO_2, % volume dry	**5.869**
Cassette 1 Filter ID	MEGPT 624		Cassette 2 Filter ID	MEGPT 621

Sample filter cassette 1, µg	37
Sample filter cassette 2, µg	38

TEST RUN RESULTS SUMMARY

Client	Microsoft MWH	*	Test number	50%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1548-1603

Standard sample volume (Vs, undiluted sample), dscm	0.4796
Standard sample volume (Vds, diluted sample), dscm	4.8300
Standard sample volume (Vc1, sample filter cassette 1), dscm	0.5860
Standard sample volume (Vc2, sample filter cassette 2), dscm	0.6036
Moisture content, %	6.33
Stack gas molecular weight, wet	28.732
Stack gas molecular weight, dry	29.458
Absolute stack pressure, in Hg	28.593
Stack gas velocity, ft/sec	70.831
Stack flow rate, acfm	18,172
Stack flow rate, wscfm	7,563
Stack flow rate, dscfm	7,084
Stack flow rate (calculated from plant fuel flow), dscfm	7,070
Isokinetic ratio, %	133.27

Sample filter cassette 1 in-stack PM concentration, µg/dscm	636
Sample filter cassette 1 grain loading, grains/dscf	2.78E-04
Sample filter cassette 1 mass emissions, lb/hr	1.68E-02
Sample filter cassette 1 mass emissions, lb/MMBtu	9.61E-04

Sample filter cassette 2 in-stack PM concentration, µg/dscm	634
Sample filter cassette 2 grain loading, gr/dscf	2.77E-04
Sample filter cassette 2 mass emissions, lb/hr	1.68E-02
Sample filter cassette 2 mass emissions, lb/MMBtu	9.59E-04

AVERAGE	
Sample filter in-stack PM concentration, µg/dscm	635
Sample filter grain loading, gr/dscf	2.77E-04
Sample filter mass emissions, lb/hr	1.68E-02
Sample filter mass emissions, lb/MMBtu	9.60E-04
Average Diff	0.1%

SOURCE TEST DATA SUMMARY

Client	Microsoft MWH	*	Test number	25%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1304-1319

Meter box ID	1538A/1527B	*	Barometric pressure, in Hg	28.60
Reference temperature, °F	68	*	Total undiluted sample volume, dscf	12.951
Stack area, square feet	4.276	*	Dilution ratio	12.826
Sample cassette flow cal factor (MF-Mix 1)	1.021	*	Sample cassette 1 flow, L/min (MF-Mix 1)	36.247
Sample cassette 2 cal factor (MF-Mix 2)	1.023	*	Sample cassette 2 flow, L/min (MF-Mix 2)	36.719
Sample time, minutes	15.92	*	142mm Filter temperature, °F	116.8
Pitot coefficient	0.8400	*	Sample venturi (Delta H), iwg	1.741
Nozzle diameter, in	0.307	*	Pitot (Delta P)	0.256
Fuel type	Diesel	*	Stack static pressure, iwg	0.1898
Fuel "HHV", Btu/gal	138,000	*	Stack temperature, °F	804.9
Fuel "F" factor (@ T_{ref}), dscf/MMBtu	9,190	*	Stack O_2, % volume dry	**15.350**
Fuel flow rate,gal/hr	74.13	*	Stack CO_2, % volume dry	**3.865**
Cassette 1 Filter ID	MEGPT 635		Cassette 2 Filter ID	MEGPT 633

Sample filter cassette 1, µg	134
Sample filter cassette 2, µg	135

TEST RUN RESULTS SUMMARY

Client	Microsoft MWH	*	Test number	25%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1304-1319

Standard sample volume (Vs, undiluted sample), dscm	0.3668
Standard sample volume (Vds, diluted sample), dscm	4.7042
Standard sample volume (Vc1, sample filter cassette 1), dscm	0.5742
Standard sample volume (Vc2, sample filter cassette 2), dscm	0.5816
Moisture content, %	5.90
Stack gas molecular weight, wet	28.570
Stack gas molecular weight, dry	29.232
Absolute stack pressure, in Hg	28.614
Stack gas velocity, ft/sec	45.138
Stack flow rate, acfm	11,581
Stack flow rate, wscfm	4,623
Stack flow rate, dscfm	4,350
Stack flow rate (calculated from plant fuel flow), dscfm	5,901
Isokinetic ratio, %	155.66
Sample filter cassette 1 in-stack PM concentration, µg/dscm	2993
Sample filter cassette 1 grain loading, grains/dscf	1.31E-03
Sample filter cassette 1 mass emissions, lb/hr	6.62E-02
Sample filter cassette 1 mass emissions, lb/MMBtu	6.47E-03
Sample filter cassette 2 in-stack PM concentration, µg/dscm	2977
Sample filter cassette 2 grain loading, gr/dscf	1.30E-03
Sample filter cassette 2 mass emissions, lb/hr	6.58E-02
Sample filter cassette 2 mass emissions, lb/MMBtu	6.43E-03
AVERAGE	
Sample filter in-stack PM concentration, µg/dscm	2985
Sample filter grain loading, gr/dscf	1.30E-03
Sample filter mass emissions, lb/hr	6.60E-02
Sample filter mass emissions, lb/MMBtu	6.45E-03
Average Diff	0.3%

SOURCE TEST DATA SUMMARY

Client	Microsoft MWH	*	Test number	10%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1640-1655

Meter box ID	1538A/1527B	*	Barometric pressure, in Hg	28.60
Reference temperature, °F	68	*	Total undiluted sample volume, dscf	12.662
Stack area, square feet	4.276	*	Dilution ratio	10.422
Sample cassette flow cal factor (MF-Mix 1)	1.021	*	Sample cassette 1 flow, L/min (MF-Mix 1)	39.929
Sample cassette 2 cal factor (MF-Mix 2)	1.023	*	Sample cassette 2 flow, L/min (MF-Mix 2)	39.120
Sample time, minutes	14.92	*	142mm Filter temperature, °F	108.0
Pitot coefficient	0.8400	*	Sample venturi (Delta H), iwg	1.846
Nozzle diameter, in	0.307	*	Pitot (Delta P)	0.104
Fuel type	Diesel	*	Stack static pressure, iwg	0.3789
Fuel "HHV", Btu/gal	138,000	*	Stack temperature, °F	760.5
Fuel "F" factor (@ T_{ref}), dscf/MMBtu	9,190	*	Stack O_2, % volume dry	**15.570**
Fuel flow rate,gal/hr	27.14	*	Stack CO_2, % volume dry	**4.804**
Cassette 1 Filter ID	MEGPT 603		Cassette 2 Filter ID	MEGPT 605

Sample filter cassette 1, µg	50
Sample filter cassette 2, µg	53

TEST RUN RESULTS SUMMARY

Client	Microsoft MWH	*	Test number	10%
Unit / Location	3.0 MW Diesel Engine	*	Date	8/21/2019
Test method	40 CFR 1065	*	Start / Stop time	1640-1655

Standard sample volume (Vs, undiluted sample), dscm	0.3586
Standard sample volume (Vds, diluted sample), dscm	3.7373
Standard sample volume (Vc1, sample filter cassette 1), dscm	0.5931
Standard sample volume (Vc2, sample filter cassette 2), dscm	0.5811
Moisture content, %	4.25
Stack gas molecular weight, wet	28.907
Stack gas molecular weight, dry	29.391
Absolute stack pressure, in Hg	28.628
Stack gas velocity, ft/sec	28.125
Stack flow rate, acfm	7,216
Stack flow rate, wscfm	2,987
Stack flow rate, dscfm	2,860
Stack flow rate (calculated from plant fuel flow), dscfm	2,249
Isokinetic ratio, %	247.02

Sample filter cassette 1 in-stack PM concentration, µg/dscm	879
Sample filter cassette 1 grain loading, grains/dscf	3.84E-04
Sample filter cassette 1 mass emissions, lb/hr	7.40E-03
Sample filter cassette 1 mass emissions, lb/MMBtu	1.98E-03

Sample filter cassette 2 in-stack PM concentration, µg/dscm	951
Sample filter cassette 2 grain loading, gr/dscf	4.15E-04
Sample filter cassette 2 mass emissions, lb/hr	8.01E-03
Sample filter cassette 2 mass emissions, lb/MMBtu	2.14E-03

AVERAGE	
Sample filter in-stack PM concentration, µg/dscm	915
Sample filter grain loading, gr/dscf	4.00E-04
Sample filter mass emissions, lb/hr	7.71E-03
Sample filter mass emissions, lb/MMBtu	2.06E-03
Average Diff	3.9%

APPENDIX B

Renewable Diesel Fuel Documentation

Renewable Hydrocarbon Diesel Certificate of Analysis

202009256022 COA

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

Analysis of REG-9000/RHD

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

Notes:

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

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

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

CATERPILLAR®

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

6/28/2021

Mycah Gambrell-Ermak
Energy & Sustainability Division,

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

Ms. Gambrell-Ermak,

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

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

Sincerely,

Evan K. Hodgen

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HVO RD99 Testing on Caterpillar C175-16

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

Engine Emissions and Load Comparisons

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

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

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

Summary of Test Results for Diesel vs. RD99 Fuel

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

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

Transient Response

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

Emissions Data

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

Engine Oil Sample Analysis

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

Fuel Sample Analysis

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

Appendix C – Test Procedure

Test Details
November 4, 2020 – Yancy CAT test facility

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

Emissions data

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

Test Procedure:

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

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

Test Instrumentation:

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

Test Fuel:

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

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator #2 Diesel

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

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator #2 Diesel

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

Notes:

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

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

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator RD99 Diesel

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

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator RD99 Diesel

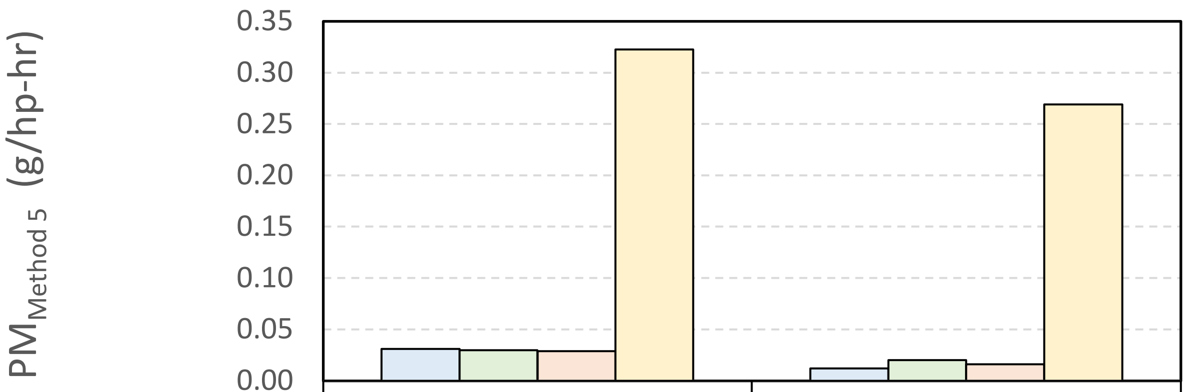
		Units	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Averages
Genset Load		% of full load	25	50	75	100	100	100	**100**
Test Date			06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	**06-Nov-20**
Start Time			7:55	9:28	10:43	11:58	13:12	14:25	**Runs**
End Time			9:00	10:31	11:47	13:04	14:17	15:30	**4,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

Notes:

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

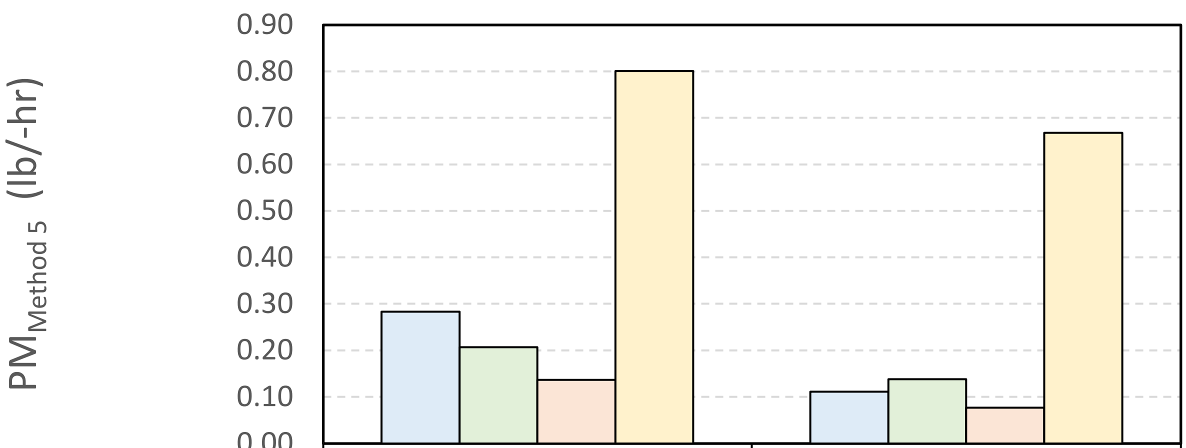
2) (<) indicates the result were below the detection limit and value used is the mininally detected value.

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



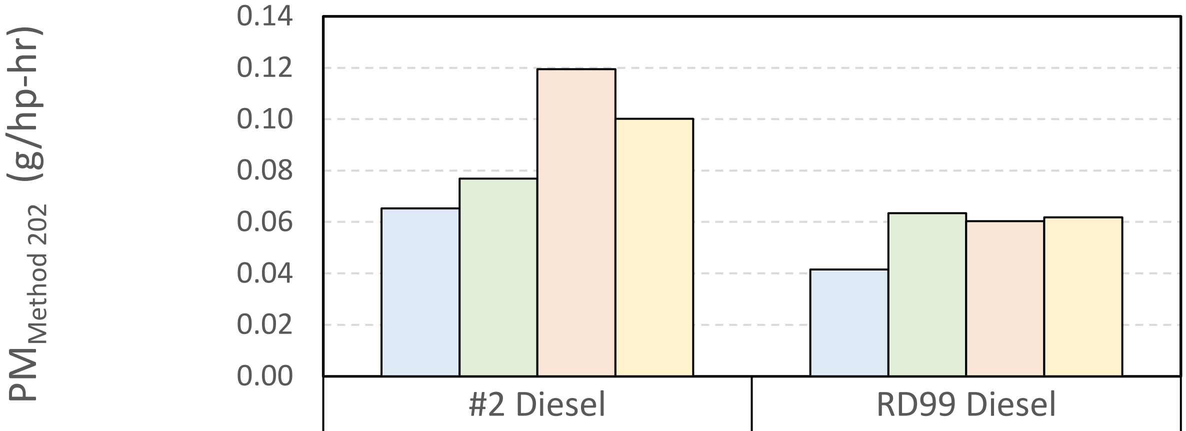
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0308	0.0121
75% of Full Load	0.0297	0.0199
50% of Full Load	0.0288	0.0161
25% of Full Load	0.3227	0.2691

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



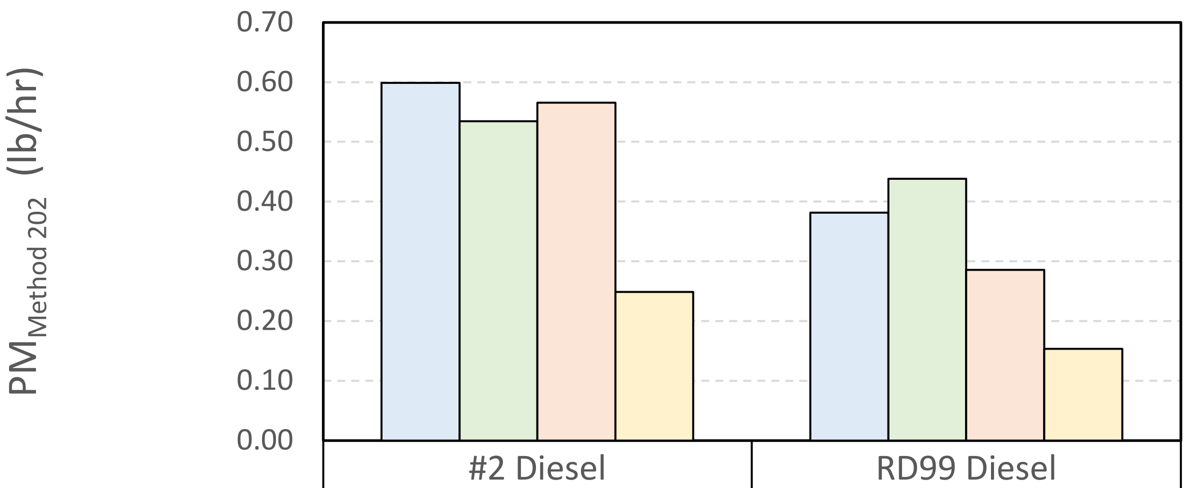
	#2 Diesel	RD99 Diesel
100% of Full Load	0.2829	0.1112
75% of Full Load	0.2066	0.1378
50% of Full Load	0.1366	0.0763
25% of Full Load	0.8010	0.6681

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



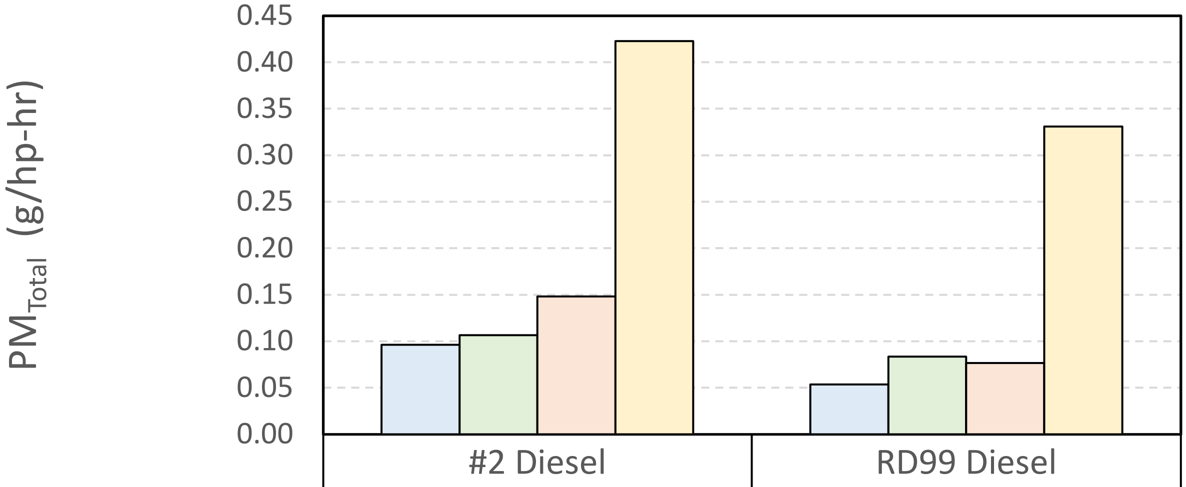
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0653	0.0415
75% of Full Load	0.0769	0.0634
50% of Full Load	0.1194	0.0603
25% of Full Load	0.1001	0.0618

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



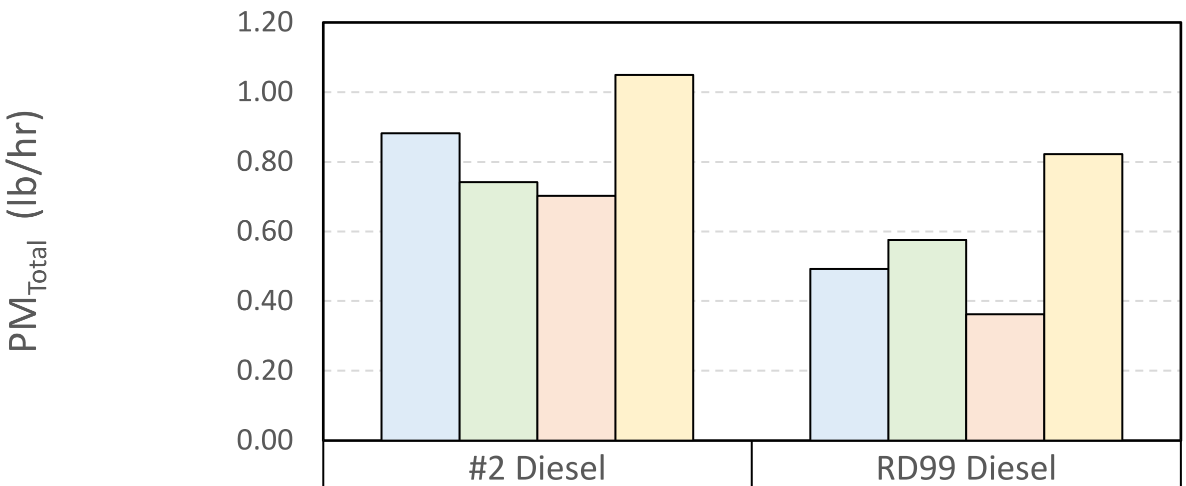
	#2 Diesel	RD99 Diesel
100% of Full Load	0.5988	0.3812
75% of Full Load	0.5342	0.4380
50% of Full Load	0.5654	0.2857
25% of Full Load	0.2486	0.1534

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



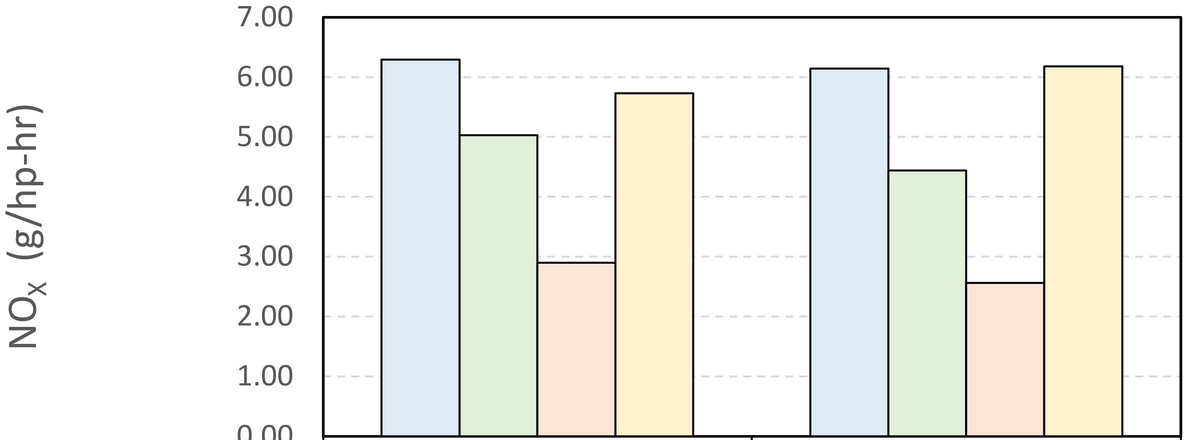
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0961	0.0536
75% of Full Load	0.1066	0.0834
50% of Full Load	0.1483	0.0764
25% of Full Load	0.4228	0.3309

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



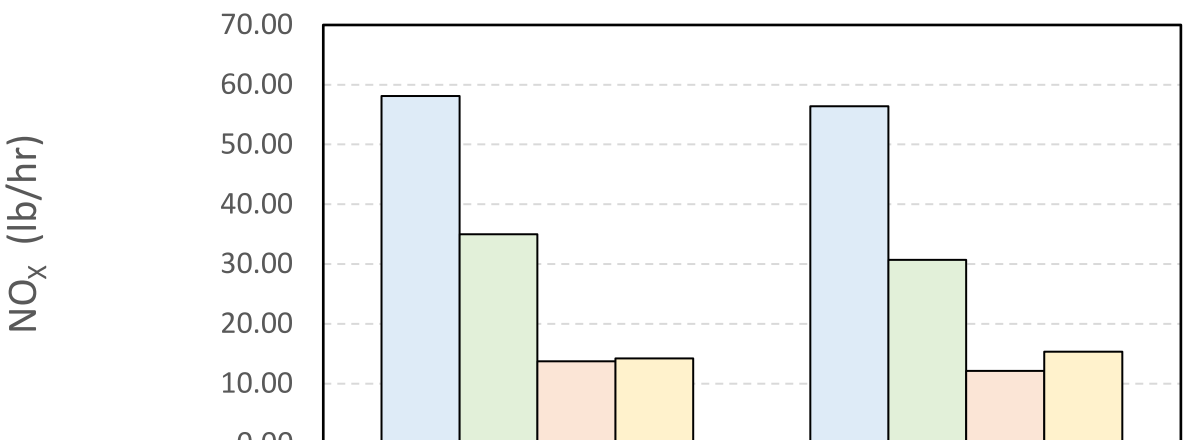
	#2 Diesel	RD99 Diesel
100% of Full Load	0.8817	0.4924
75% of Full Load	0.7409	0.5757
50% of Full Load	0.7021	0.3620
25% of Full Load	1.0495	0.8214

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



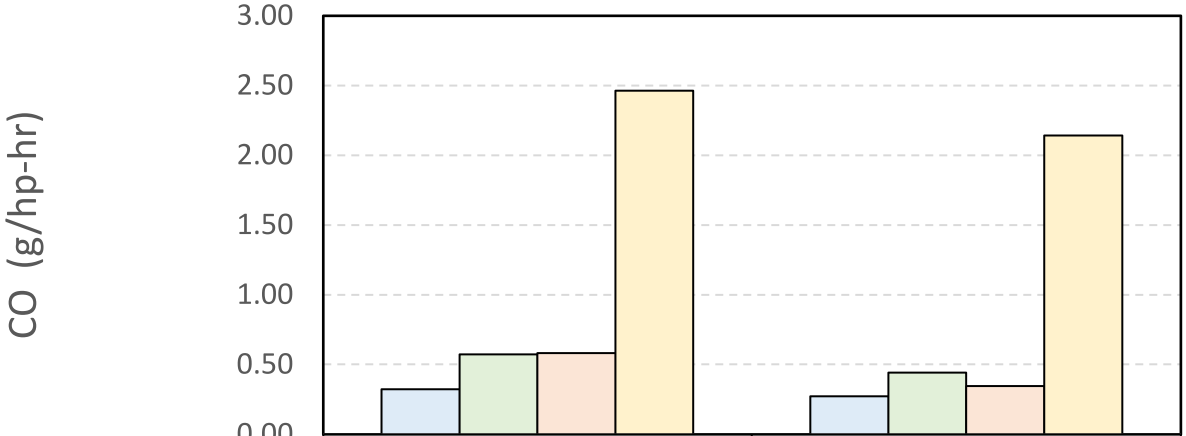
	#2 Diesel	RD99 Diesel
100% of Full Load	6.2908	6.1399
75% of Full Load	5.0312	4.4419
50% of Full Load	2.8958	2.5598
25% of Full Load	5.7292	6.1802

Emissions Test Comparisons - NO_X (lb/hr)



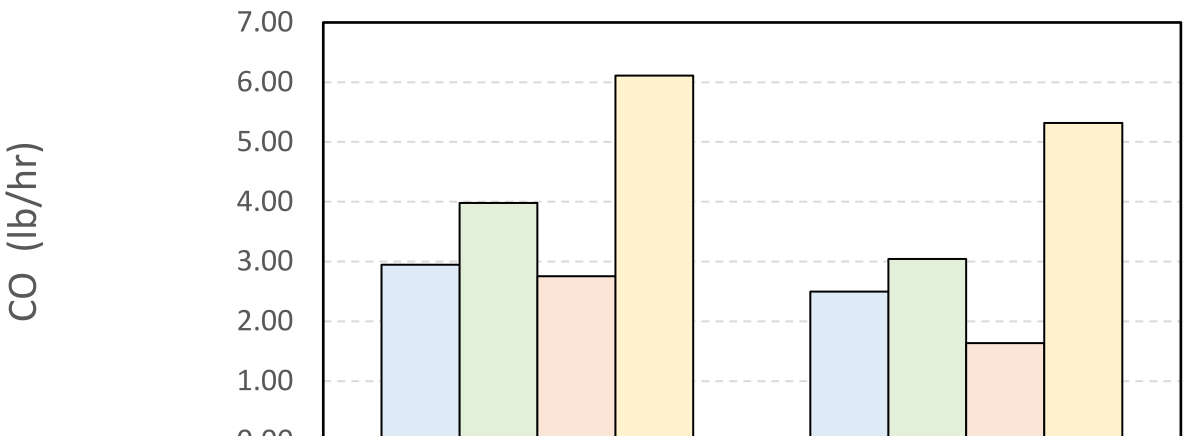
	#2 Diesel	RD99 Diesel
100% of Full Load	58.0785	56.3874
75% of Full Load	34.9503	30.6804
50% of Full Load	13.7131	12.1221
25% of Full Load	14.2221	15.3419

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

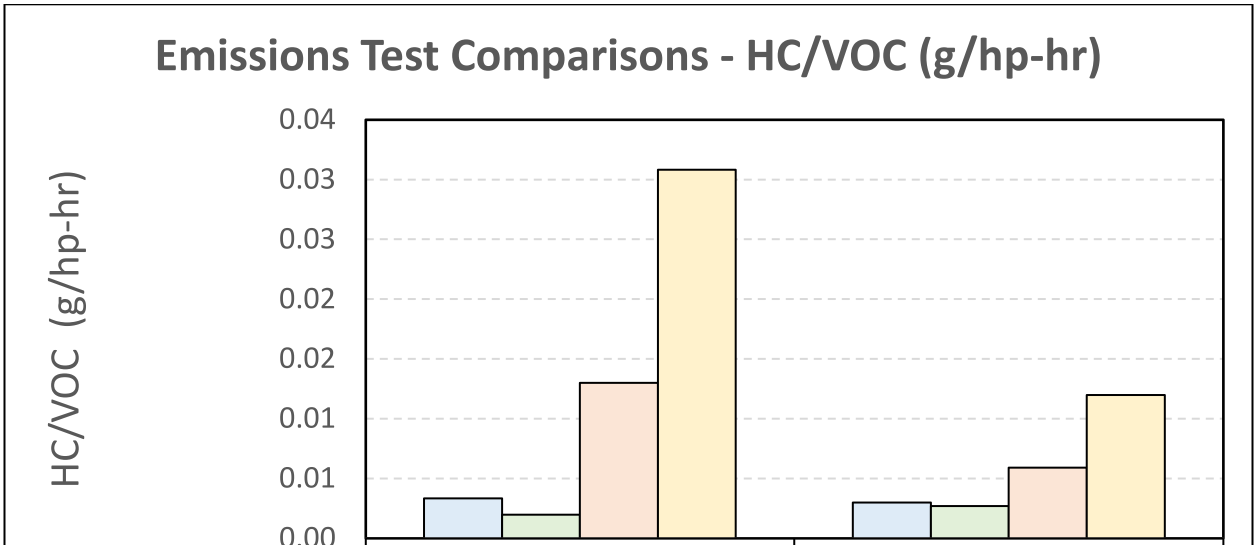


	#2 Diesel	RD99 Diesel
100% of Full Load	0.3212	0.2721
75% of Full Load	0.5726	0.4408
50% of Full Load	0.5809	0.3450
25% of Full Load	2.4619	2.1417

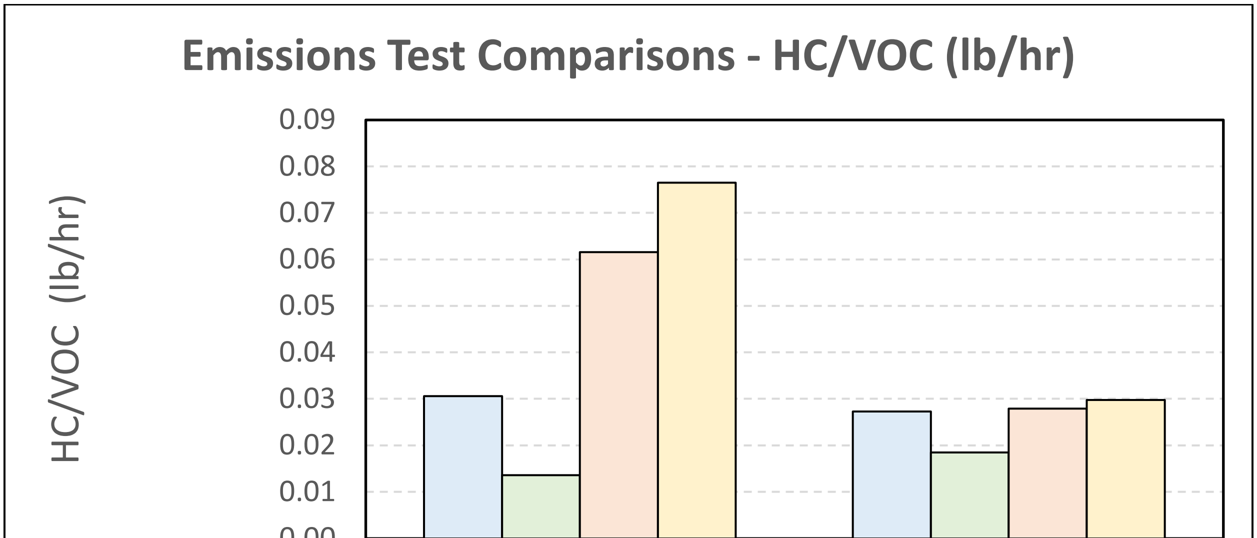
Emissions Test Comparisons - CO (lb/hr)



	#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

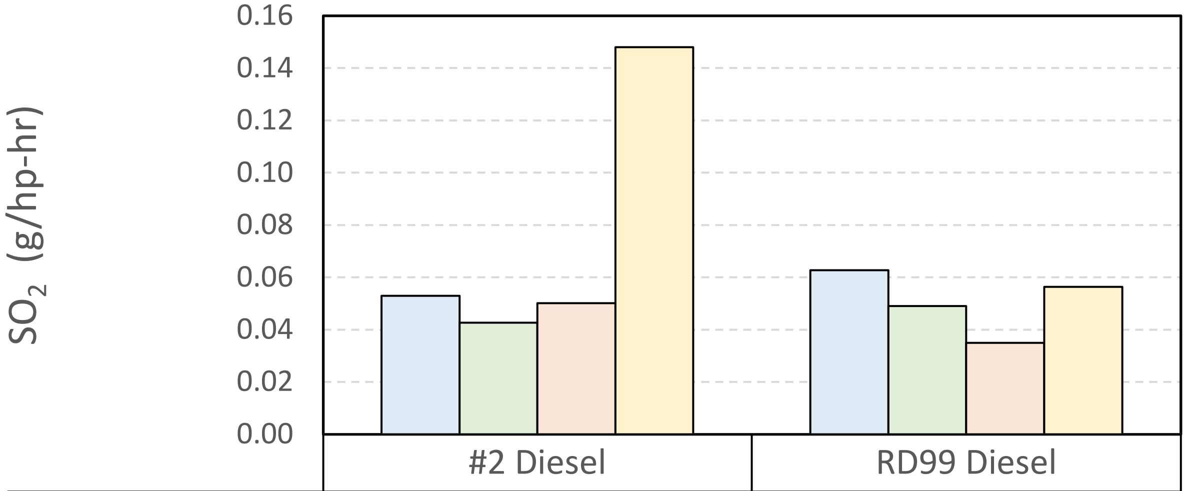


	#2 Diesel	RD99 Diesel
100% of Full Load	0.0033	0.0030
75% of Full Load	0.0020	0.0027
50% of Full Load	0.0130	0.0059
25% of Full Load	0.0308	0.0120



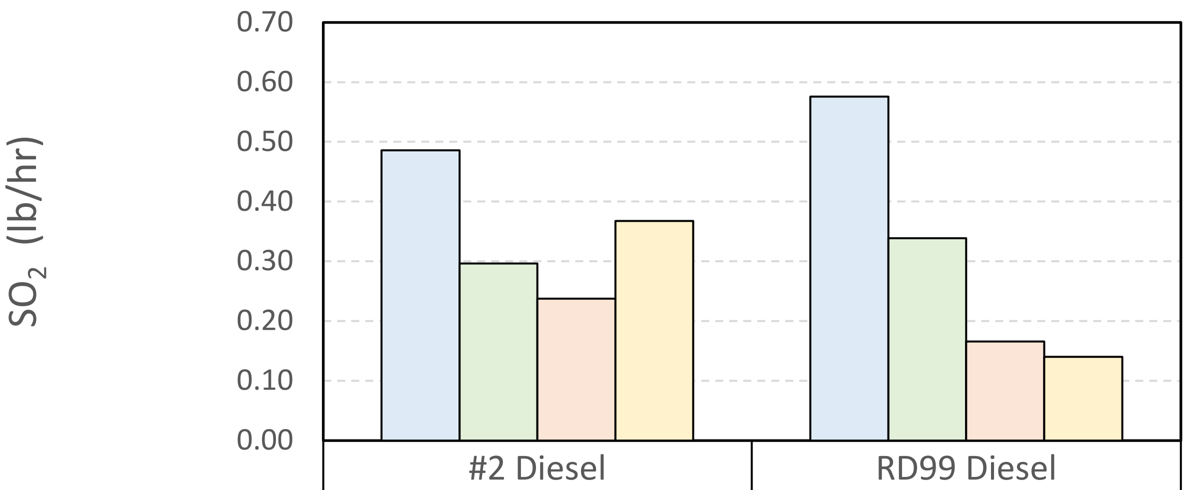
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0306	0.0273
75% of Full Load	0.0136	0.0185
50% of Full Load	0.0616	0.0279
25% of Full Load	0.0765	0.0297

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



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

Emissions Test Comparisons - SO_2 (lb/hr)



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

APPENDIX C

Startup Emissions Estimation Method

APPENDIX C
Diesel Generator "Cold-Start Spike" Adjustment Factors

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

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

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

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

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

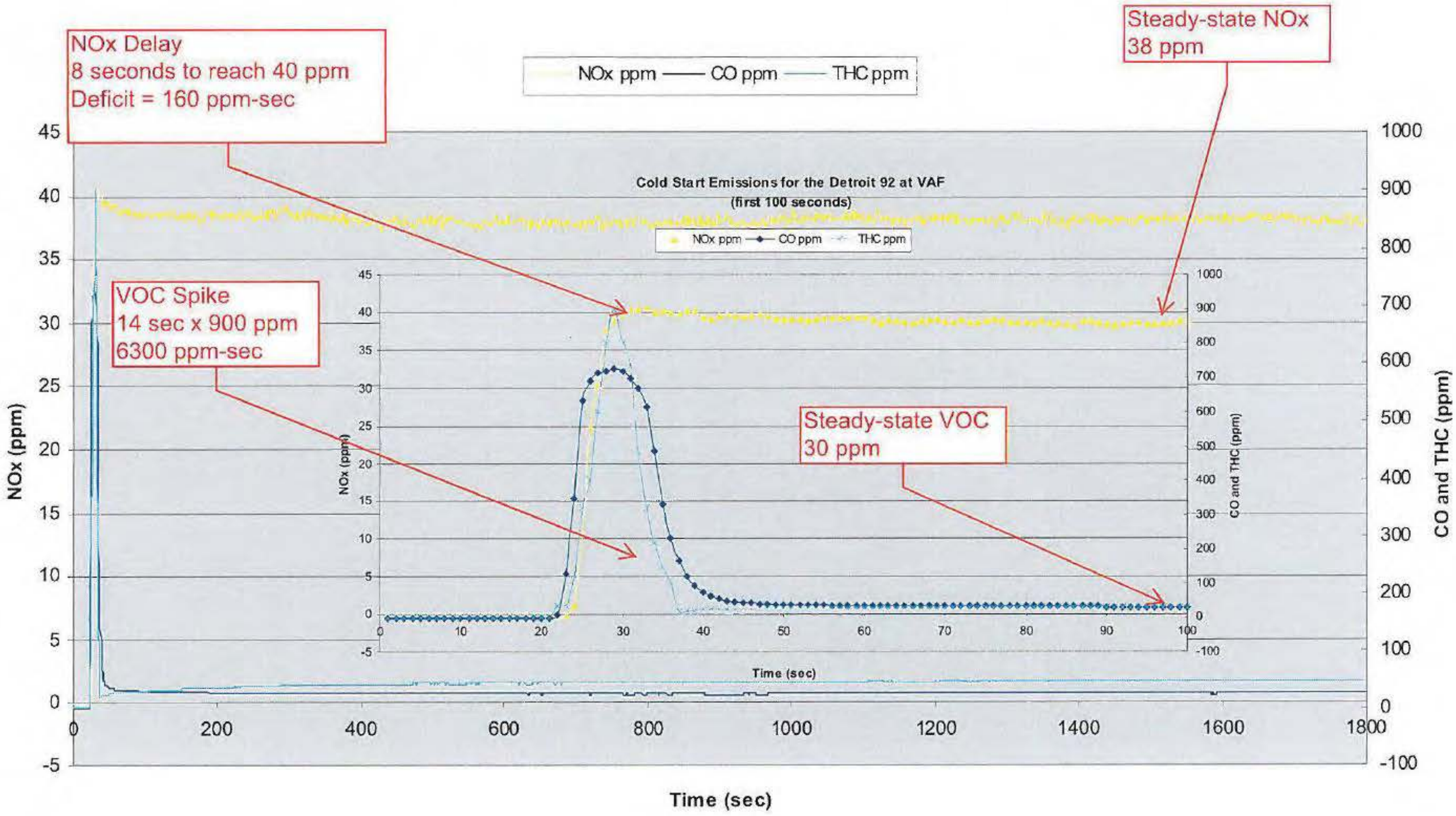
Example: Cold-Start Spike Factor for VOCs, first 1-minute after cold-start at low load.

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

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

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

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



Source: Lents et al. 2005.

Microsoft Corporation East Wenatchee Campus Douglas County, Washington	**Cold-Start Emission Trends**	Figure C-1

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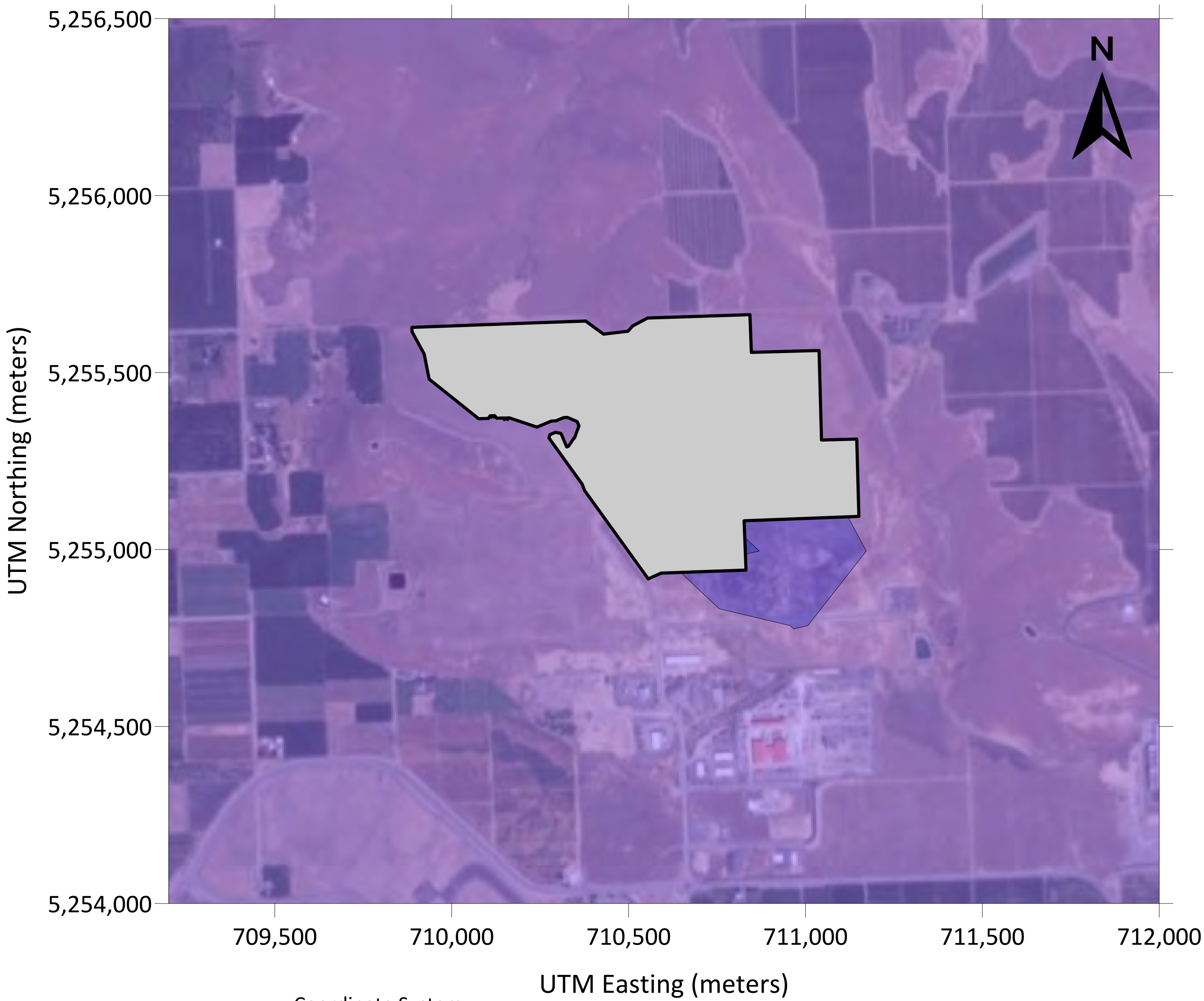
APPENDIX D

Summary of AERMOD Inputs, Selected Isopleths, and Monte Carlo Analysis



Note
1. Plot file of annual values averaged across 5 years for source group: Project
2. ASIL = 0.0033 µg/m³
3. Max = 0.012 µg/m³
4. Project No.: 1409015.030
5. Sources: 22
6. µg/m³ = micrograms per cubic meter3

Coordinate System:
UTM NAD83 Zone 10

Scale:
0 m 200 m 400 m 600 m

Data Source: Google Maps; AERMOD model DEEP.ann.NonCR.PROJ.5Y.inp

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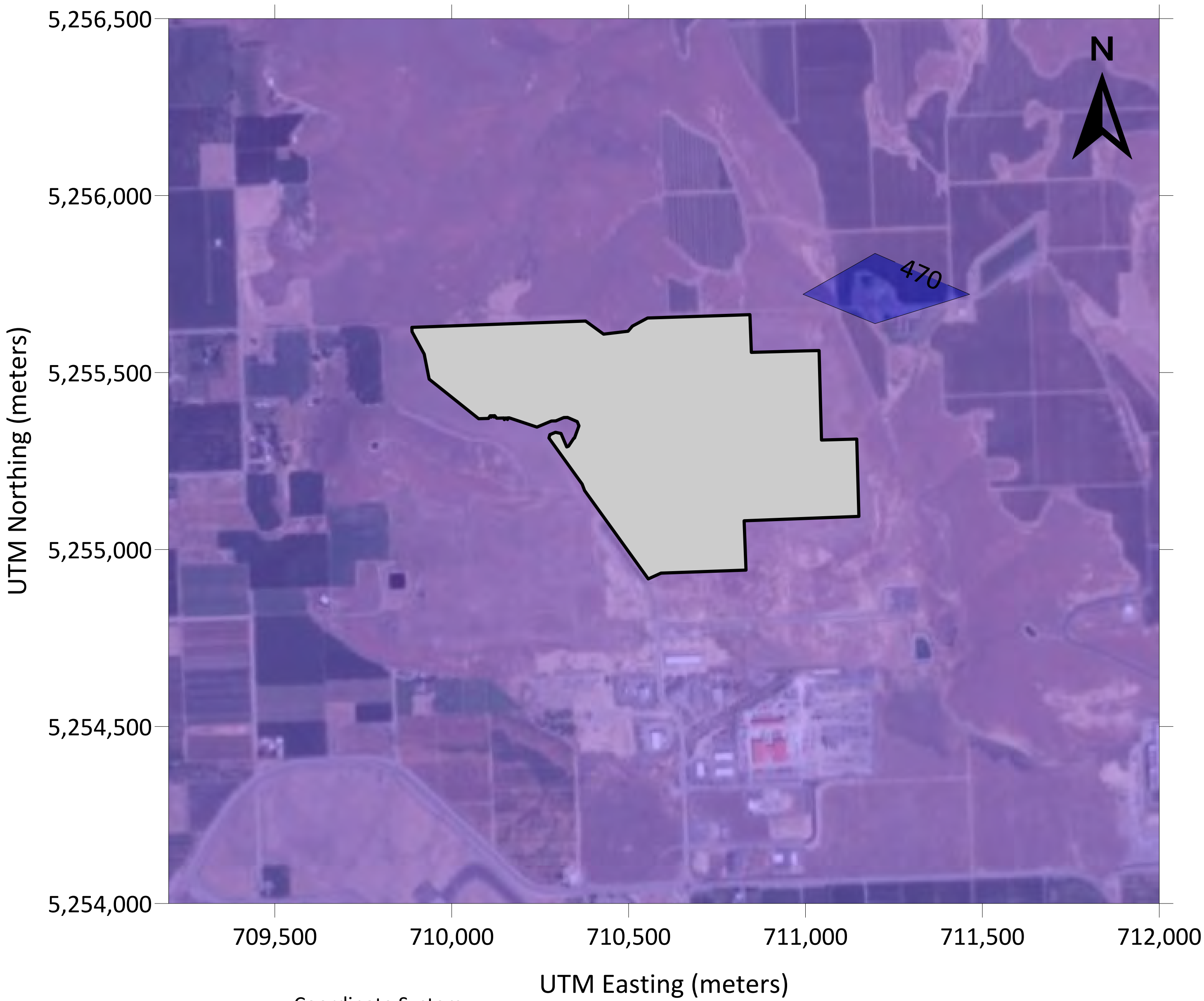
Microsoft Corporation
East Wenatchee Data Center Campus
Douglas County, Washington

DEEP Annual Average Concentration

Figure
D-1



Legend

Fence Line

NO_2 Concentration Contour Levels

850

470

50

Note

1. Plot file of high 1st high 1-hour values for source group: ALL
2. ASIL = 470 µg/m³
3. Max = 758 µg/m³
4. Project No.: 1409015.030
5. Sources: 22
6. µg/m³ = micrograms per cubic meter

Coordinate System:
UTM NAD83 Zone 10

Scale:
0 m 200 m 400 m 600 m

Data Source: Google Maps; AERMOD model NO2.1HR.HIA.ASIL.PROJECT.5Y.inp

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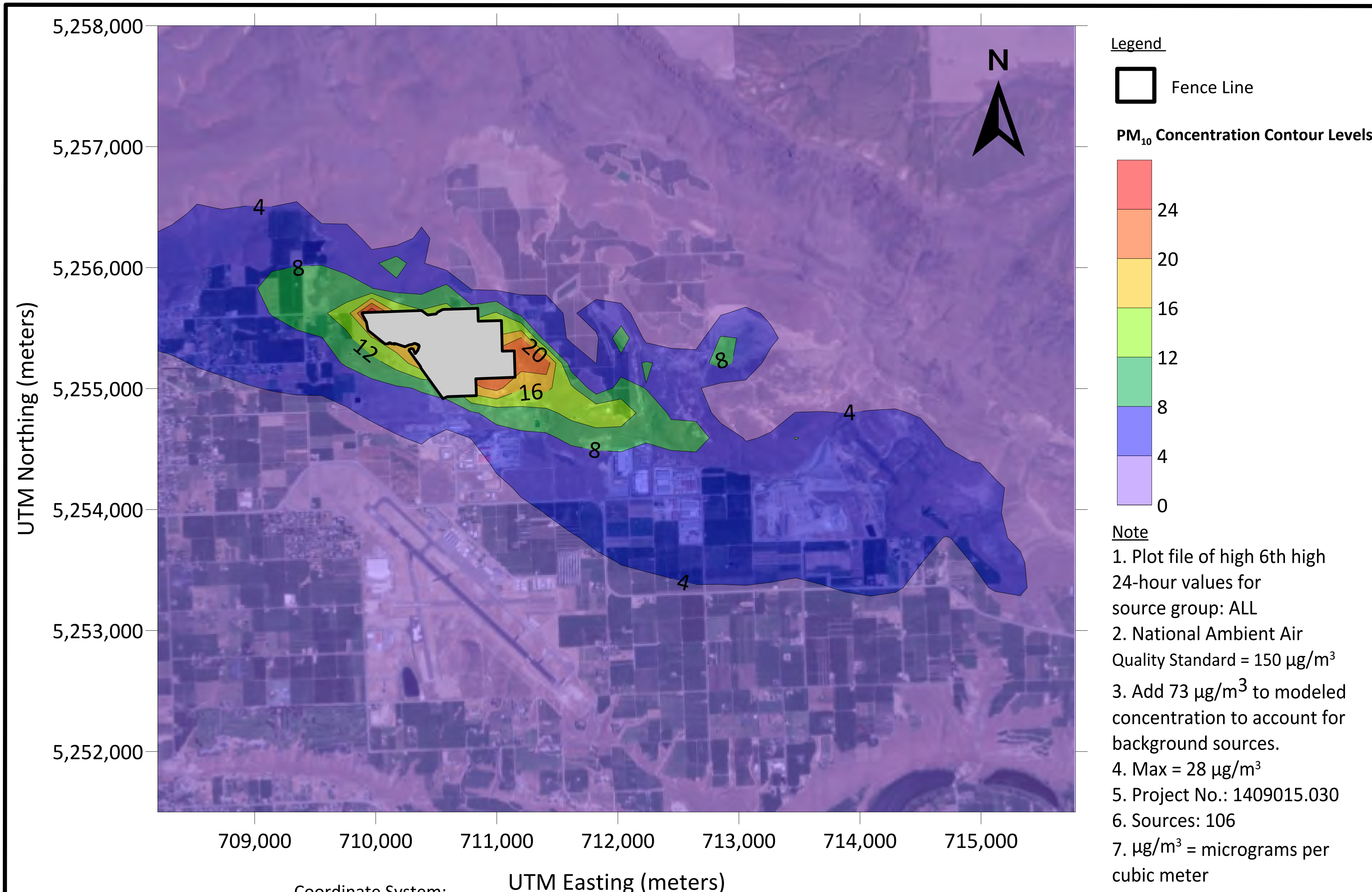
Microsoft Corporation East Wenatchee Data Center Campus Douglas County, Washington	**NO_2 1-hour Average Concentration**	Figure D-2



Note

1. Plot file of high 6th high 24-hour values for source group: ALL
2. National Ambient Air Quality Standard = 150 μg/m^3
3. Add 73 μg/m^3 to modeled concentration to account for background sources.
4. Max = 28 μg/m^3
5. Project No.: 1409015.030
6. Sources: 106
7. μg/m^3 = micrograms per cubic meter

Coordinate System:
UTM NAD83 Zone 10

Scale:

0 m 500 m 1000 m 1500 m

Data Source: Google Maps; AERMOD model PM10.24hr.PO.5Y.inp

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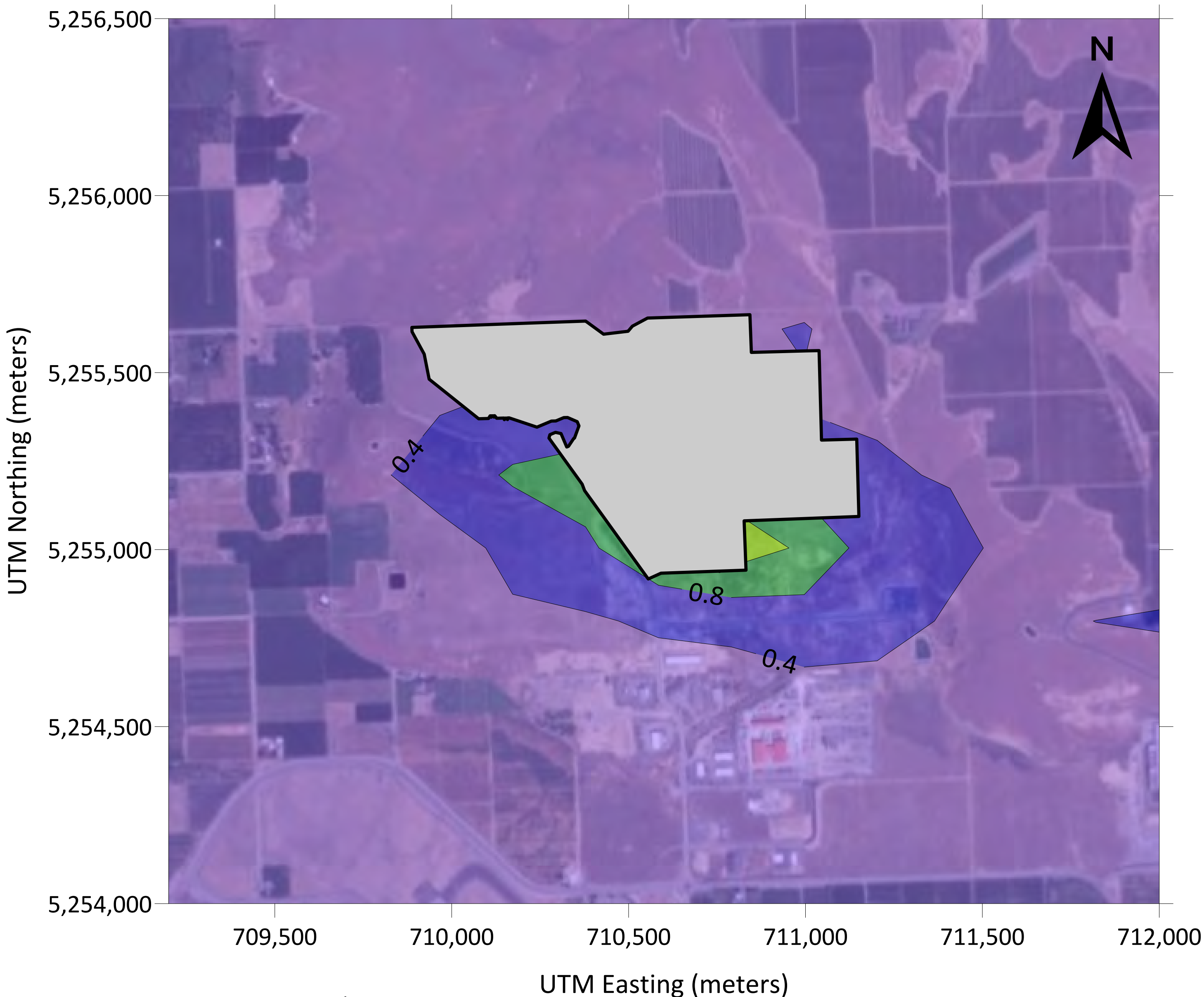
Microsoft Corporation East Wenatchee Data Center Campus Douglas County, Washington	**PM_{10} 24-hour Average Concentration**	Figure D-3



Legend

Fence Line

$PM_{2.5}$ Concentration Contour Levels

1.6
1.2
0.8
0.4
0

Note

1. Plot file of high 1st high 24-hour values averaged over 5 years for source group: CIST
2. National Ambient Air Quality Standard = 35 µg/m^3
3. Add 23 µg/m^3 to modeled concentration to account for background sources
4. Max = 1.7 µg/m^3
5. Project No.: 1409015.030
6. Sources: 5
7. µg/m^3 = micrograms per cubic meter

Coordinate System:
UTM NAD83 Zone 10

Scale:
0 m 200 m 400 m 600 m

Data Source: Google Maps; AERMOD model PM25.24hr.CIST.5Y.inp

LANDAU ASSOCIATES

Microsoft Corporation East Wenatchee Data Center Campus Douglas County, Washington	**$PM_{2.5}$ 24-hour Average Concentration**	Figure D-4

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Stack Dimensions

Genset	Minimum Stack Height (ft)	Actual Stack Diameter (in)
EAT02 - CAT C175 3.0 MWe Genset (Tier 2)	72	24
EAT02 - CAT C15 0.5 MWe Genset (Tier 2)	30	8
EAT03-04-05 - CAT C175 3.0 MWe Genset (Tier 4)	72	24
EAT03-04-05 - CAT C15 0.5 MWe Genset (Tier 2)	30	10
EAT06-09 - CAT C175 3.0 MWe Genset (Tier 4)	72	24
EAT06-09 - CAT C15 0.5 MWe Genset (Tier 4)	30	10
Nonroad Engine - CAT 3516C 2.0 MWe Genset (Tier 4)	13	12
Nonroad Engine - CAT C18 1.0 MWe Genset (Tier 4)	12	5

Exhaust Parameters and Modeled Emission Rates

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
EAT02 - CAT C175 3.0 MWe Genset (Tier 2)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	642	3,302	2.4	8.62E+00
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	671	4,104	2.4	4.54E-02
PM_{10}	24-hour	Emergency Power Outage	9	1	539	487	517	3.1	4.09E-01
$PM_{2.5}$	Annual	Regular Annual (EO, PM, ST, QT)	50	20	2,968	487	517	3.1	6.30E-03
	24-hour	*Modeled based on EAT06&09 Commissioning - Integrated Systems Test scenario*							
NO_X	Annual	Regular Annual (EO, PM, ST, QT)	50	20	2,968	671	4,104	2.4	4.03E-01
	1-hour	Variable Load	1	1	59	671	4,104	2.4	7.08E+01
		Monthly Maintenance	1	2	58	487	517	3.1	7.39E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	671	4,104	2.4	7.08E+01

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	642	3,302	2.4	4.75E+01
DEEP	Annual	Regular Annual (EO, PM, ST, QT)	50	20	2,968	487	517	3.1	1.88E-03
EAT02 - CAT C15 0.5 MWe Genset (Tier 2)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	711	4,793	0.8	2.47E+00
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	741	5,423	0.8	7.60E-03
PM_{10}	24-hour	Emergency Power Outage	9	1	539	380	567	1.0	6.04E-02
$PM_{2.5}$	Annual	Regular Annual (EO, PM, ST, QT)	65	24	3,876	380	567	1.0	1.21E-03
	24-hour	*Modeled based on EAT06&09 Commissioning - Integrated Systems Test scenario*							
NO_X	Annual	Regular Annual (EO, PM, ST, QT)	65	24	3,876	741	5,423	0.8	6.06E-02
	1-hour	Variable Load	1	1	59	741	5,423	0.8	8.17E+00
		Monthly Maintenance	1	2	58	380	567	1.0	1.77E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	741	5,423	0.8	8.17E+00
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	711	4,793	0.8	3.71E+00
DEEP	Annual	Regular Annual (EO, PM, ST, QT)	65	24	3,876	666	3,069	0.8	1.29E-03
EAT03-04-05 - CAT C175 3.0 MWe Genset (Tier 4)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	453	373	3.1	1.83E+00
CO (75% Load)	1-hour	Emergency Power Outage	1	1	59	649	3,323	2.4	1.69E+00
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	669	4,231	2.4	4.45E-02
PM_{10}	24-hour	Emergency Power Outage	9	1	539	453	373	3.1	1.80E-01

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
$PM_{2.5}$	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	63	19	3,749	453	373	3.1	3.47E-03
		EAT04 - Regular Annual (EO, PM, ST)	39	14	2,314	453	373	3.1	2.15E-03
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	91	66	5,382	453	373	3.1	5.14E-03
	24-hour	*Modeled based on EAT06&09 Commissioning - Integrated Systems Test scenario*							
NO_X	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	63	19	3,749	669	4,231	2.4	1.97E-01
		EAT04 - Regular Annual (EO, PM, ST)	39	14	2,314	669	4,231	2.4	1.22E-01
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	91	66	5,382	669	4,231	2.4	2.86E-01
	1-hour	Variable Load	1	1	59	669	4,231	2.4	2.75E+01
		Monthly Maintenance[c]	1	2	58	453	373	3.1	7.90E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	669	4,231	2.4	2.75E+01
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	649	3,323	2.4	1.76E+01
DEEP	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	63	19	3,749	453	373	3.1	3.06E-04
		EAT04 - Regular Annual (EO, PM, ST)	39	14	2,314	453	373	3.1	1.90E-04
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	91	66	5,382	453	373	3.1	4.53E-04
EAT03-04-05 - CAT C15 0.5 MWe Genset (Tier 2)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	711	3,068	1.0	2.47E+00

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	741	3,471	1.0	7.60E-03
PM_{10}	24-hour	Emergency Power Outage	9	1	539	666	1,964	1.0	9.05E-02
$PM_{2.5}$	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	78	23	4,657	380	363	1.3	1.45E-03
		EAT04 - Regular Annual (EO, PM, ST)	54	18	3,222	380	363	1.3	1.00E-03
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	106	70	6,290	380	363	1.3	2.01E-03
	24-hour	*Modeled based on EAT06&09 Commissioning - Integrated Systems Test scenario*							
NO_X	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	78	23	4,657	741	3,471	1.0	8.15E-02
		EAT04 - Regular Annual (EO, PM, ST)	54	18	3,222	741	3,471	1.0	5.64E-02
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	106	70	6,290	741	3,471	1.0	1.11E-01
	1-hour	Variable Load	1	1	59	508	845	1.0	3.38E+00
		Monthly Maintenance[c]	1	2	58	380	363	1.3	1.98E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	508	845	1.0	3.38E+00
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	711	3,068	1.0	4.16E+00
DEEP	Annual	EAT03 - Regular Annual (EO, PM, ST, QT)	78	23	4,657	666	1,964	1.0	1.54E-03
		EAT04 - Regular Annual (EO, PM, ST)	54	18	3,222	666	1,964	1.0	1.07E-03
		EAT05 - Commissioning + Regular Annual (EO, PM, CM, ST)	106	70	6,290	666	1,964	1.0	2.13E-03

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
EAT06-09 - CAT C175 3.0 MWe Genset (Tier 4)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	453	373	3.1	1.83E+00
CO (75% Load)	1-hour	Emergency Power Outage	1	1	59	649	3,323	2.4	1.69E+00
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	669	4,231	2.4	4.45E-02
PM_{10}	24-hour	Emergency Power Outage	9	1	539	453	373	3.1	1.80E-01
$PM_{2.5}$	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	87	62	5,146	453	373	3.1	4.91E-03
	24-hour	Commissioning - Integrated Systems Test	4	4	236	453	373	3.1	1.67E-01
NO_X	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	87	62	5,146	669	4,231	2.4	2.73E-01
	1-hour	Variable Load	1	1	59	669	4,231	2.4	2.75E+01
		Monthly Maintenance[c]	1	2	58	453	373	3.1	7.90E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	669	4,231	2.4	2.75E+01
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	649	3,323	2.4	1.76E+01
CO	1-hour	Emergency Power Outage	1	1	59	453	373	3.1	1.83E+00
DEEP	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	87	62	5,146	453	373	3.1	4.32E-04
Acrolein	24-hour	Emergency Power Outage	9	1	539	669	4,231	2.4	1.34E-03
EAT06-09 - CAT C15 0.5 MWe Genset (Tier 4)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	379	363	1.3	3.76E-01
CO (75% Load)	1-hour	Emergency Power Outage	1	1	59	711	3,068	1.0	4.94E-01

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours			Exhaust Parameters[a]			Emissions per Point Source[b] (lb/hr)
			Total Hours of Operation (hr)	Cold-Start Minutes (min)	Warm Minutes (min)	Exhaust Temperature (°F)	Adjusted Velocity (ft/min)	Effective Stack Diameter (ft)	
SO_2	1-hour and 3-hour	Emergency Power Outage	1	1	59	741	3,471	1.0	7.60E-03
PM_{10}	24-hour	Emergency Power Outage	9	1	539	379	363	1.3	3.11E-02
$PM_{2.5}$	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	94	64	5,576	379	363	1.3	9.18E-04
	24-hour	Commissioning - Integrated Systems Test	4	4	236	379	363	1.3	2.90E-02
NO_X	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	94	64	5,576	379	363	1.3	2.12E-02
	1-hour	Variable Load	1	1	59	379	363	1.3	1.98E+00
		Monthly Maintenance[c]	1	2	58	379	363	1.3	1.98E+00
Toxic Air Pollutants									
Primary NO_2	1-hour	Emergency Power Outage	1	1	59	379	363	1.3	1.98E+00
Primary NO_2 (75% Load)	1-hour	Emergency Power Outage	1	1	59	711	3,068	1.0	1.61E+00
CO	1-hour	Emergency Power Outage	1	1	59	379	363	1.3	3.76E-01
DEEP	Annual	Commissioning + Regular Annual (EO, PM, CM, ST)	94	64	5,576	508	845	1.0	1.84E-04
Acrolein	24-hour	Emergency Power Outage	9	1	539	741	3,471	1.0	1.34E-03
Nonroad Engine - CAT 3516C 2.0 MWe Genset (Tier 4)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	369	1,249	1.5	7.93E-01
PM_{10}	24-hour	Emergency Power Outage	9	1	539	369	1,249	1.5	1.47E-01
$PM_{2.5}$	Annual	Regular Annual (EO, PM, 2 hours of installation)	40	16	2,384	369	1,249	1.5	1.82E-03
	24-hour	Commissioning - Integrated Systems Test	4	4	236	369	1,249	1.5	1.37E-01
NO_X	Annual	Regular Annual (EO, PM, 2 hours of installation)	40	16	2,384	369	1,249	1.5	7.53E-02

Table D-1
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Pollutant	Averaging Period	Emissions Scenario	Operating Hours: Total Hours of Operation (hr)	Operating Hours: Cold-Start Minutes (min)	Operating Hours: Warm Minutes (min)	Exhaust Parameters[a]: Exhaust Temperature (°F)	Exhaust Parameters[a]: Adjusted Velocity (ft/min)	Exhaust Parameters[a]: Effective Stack Diameter (ft)	Emissions per Point Source[b] (lb/hr)
Nonroad Engine - CAT C18 1.0 MWe Genset (Tier 4)									
Criteria Air Pollutants									
CO	1-hour and 8-hour	Emergency Power Outage	1	1	59	320	1,755	0.6	2.24E-02
PM_{10}	24-hour	Emergency Power Outage	9	1	539	320	1,755	0.6	6.04E-02
$PM_{2.5}$	Annual	Regular Annual (EO, PM, 2 hours of installation)	40	16	2,384	320	1,755	0.6	7.47E-04
	24-hour	Commissioning - Integrated Systems Test	4	4	236	320	1,755	0.6	5.62E-02
NO_X	Annual	Regular Annual (EO, PM, 2 hours of installation)	40	16	2,384	320	1,755	0.6	3.80E-02

Notes:

a. Velocity for operations at 10 percent load were adjusted using a scaling factor to represent a vertical stack with a rain cap open to a 30 degree angle. Velocity for operations above 10 percent load were adjusted using a scaling factor to represent a vertical stack with a rain cap open to a 45 degree angle. The effective stack diameter was calculated by dividing the actual flow by the adjusted velocity.

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

c. Monthly maintenance operates at 10% load. A 1-hour emission rate was modeled to represent two generators running sequentially each hour for 0.5-hour each.

d. For nonroad engines, exhaust parameters for 10% load is modeled along with emissions based on the worst-case load emissions from manufacturer's specifications.

Table D-2
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Ranked Day	Building	Activity[a]	Activity Duration (hrs/genset)	Number of Generators Operating Concurrently	Max. Daily Operating Hours (hrs/day)	Cold Startup Hours (hrs/day)	Load Required (%)	Max. Daily $PM_{2.5}/PM_{10}$ Emissions[b] (lbs/day)
1	All	Emergency Operations	9	106	9	1	≤100	545
2	All	Emergency Operations	9	106	9	1	≤100	545
3	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4
4	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4
5	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4
6	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4
7	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4
8	EAT 06-09	Commissioning - Integrated Systems Test	4	5	4	4	≤100	8.4

Notes:

a. A cold startup hour for PM includes 1 minute of cold-start emissions and 59 minutes of regular emissions.

b. Includes all cold startup hour and regular hour emissions.

Table D-3
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Generator Runtime Scenario[a, b]		Load (%)	Max. Gensets Operating Concurrently (gensets)	Number of Operating Days (days/yr)	AERMOD Data Information		
Building	Activity				Source Group	Monte Carlo Input Filename	AERMOD Filename
Annual Operations							
ALL	Emergency Operations	≤100	106	2	PO	MAXDAILY_NO2_PO.DAT	NO2.1HR.PO.5Y.inp
02 05	Monthly Maintenance Commissioning - Burn-In & Step-Load Test	10 ≤100	1 1	Unlimited	MT	MAXDAILY_NO2_MT02.DAT	NO2.1HR.MT02.5Y.inp
02 05	Quarterly and Annual Maintenance Commissioning - Burn-In & Step-Load Test	≤100 ≤100	1 1	40	QA	MAXDAILY_NO2_QA02.DAT	NO2.1HR.QA02.5Y.inp
03 or 04 05	Monthly Maintenance Commissioning - Burn-In & Step-Load Test	10 ≤100	1 1	Unlimited	MT	MAXDAILY_NO2_MT0304_CBIST05.DAT	NO2.1HR.MT0304.CBIST05.5Y.inp
03 or 04 05	Monthly Maintenance Commissioning - Transfer Control	10 10	1 1	12	MT	MAXDAILY_NO2_MT0304_CTC05.DAT	NO2.1HR.MT0304.CTC05.5Y.inp
03 or 04 05	Quarterly and Annual Maintenance Commissioning - Transfer Control	≤100 10	1 1	38	QA	MAXDAILY_NO2_QA0304_CTC05.DAT	NO2.1HR.QA0304.CTC05.5Y.inp
03 or 04 06 or 09	Quarterly and Annual Maintenance Commissioning - Burn-In & Step-Load Test	≤100 ≤100	1 1	42	QA	MAXDAILY_NO2_QA0304_CBIST06.DAT	NO2.1HR.QA0304.CBIST06.5Y.inp
05 06 or 09	Monthly Maintenance Commissioning - Burn-In & Step-Load Test	10 ≤100	1 1	20	MT	MAXDAILY_NO2_MT05.DAT	NO2.1HR.MT05.5Y.inp
05 06 or 09	Quarterly Maintenance Commissioning - Burn-In & Step-Load Test	≤100 ≤100	1 1	20	QM	MAXDAILY_NO2_QM05.DAT	NO2.1HR.QM05.5Y.inp
05	Commissioning - Integrated Systems Test	≤100	5	12	CIST	MAXDAILY_NO2_CIST05.DAT	NO2.1HR.CIST05.5Y.inp
06 or 09	Monthly Maintenance	10	1	Unlimited	MT	MAXDAILY_NO2_MT0609.DAT	NO2.1HR.MT0609.5Y.inp

Table D-3
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

06 or 09	Commissioning - Burn-In & Step-Load Test	≤100	1	Unlimited	CBIST	MAXDAILY_NO2_CBIST.DAT	NO2.1HR.CBIST.5Y.inp
06 or 09	Commissioning - Transfer Control	10	1	Unlimited	CTC	MAXDAILY_NO2_CTC.DAT	NO2.1HR.CTC.5Y.inp
06 or 09	Commissioning - Integrated Systems Test	≤100	5	12	CIST	MAXDAILY_NO2_CIST0609.DAT	NO2.1HR.CIST0609.5Y.inp
Every 5-Year Events [c]							
02	Stack Testing	≤100	1	4	5YR	MAXDAILY_NO2_ST02_2018.DAT	NO2.1HR.ST02.2018.inp
02	Switchgear Testing & Pad-Mounted Switchgear Testing	≤100	5	15	5YR	MAXDAILY_NO2_SGT02_2018.DAT	NO2.1HR.SGT02.2018.inp
03	Stack Testing	≤100	1	Unlimited	5YR	MAXDAILY_NO2_ST03.DAT	NO2.1HR.ST03.5Y.inp
03	Switchgear Testing & Pad-Mounted Switchgear Testing	≤100	5	15	5YR	MAXDAILY_NO2_SGT03_2018.DAT	NO2.1HR.SGT03.2018.inp
04	Stack Testing	≤100	1	Unlimited	5YR	MAXDAILY_NO2_ST04.DAT	NO2.1HR.ST04.5Y.inp
04	Switchgear Testing & Pad-Mounted Switchgear Testing	≤100	5	15	5YR	MAXDAILY_NO2_SGT04_2018.DAT	NO2.1HR.SGT04.2018.inp
05, 06 or 09	Stack Testing	≤100	1	Unlimited	5YR	MAXDAILY_NO2_ST050609.DAT	NO2.1HR.ST050609.5Y.inp
05, 06 or 09	Switchgear Testing & Pad-Mounted Switchgear Testing	≤100	5	30	5YR	MAXDAILY_NO2_SGT050609_2019.DAT	NO2.1HR.SGT050609.2019.inp

Table D-3
Modeled Stack Parameters and Emission Rates
EAT06 and EAT09 Data Centers, East Wenatchee Data Center Campus
Douglas County, Washington

Notes:

a. Based on a potential 12-month period where all buildings are conducting emergency operations, preventative maintenance, and stack testing, plus EAT02 and EAT03 conducting additional quinquennial testing, and EAT05 and EAT06/09 conducting additional commissioning. For EAT05 and EAT06/09, the preventative maintenance is only partial of a full year to account for concurrent commissioning activities in the same year.

b. Assumes that commissioning activities (burn-in, step-load test, and transfer control test) will occur for a building at the same time as regular preventative maintenance activities for a different building.

c. Stack testing and switchgear testing occur every five years for each building. Assumes no more than two buildings will be undergoing quinquennial testing in a single year.

d. All NO_2 models include regional background from the "Quincy 3rd Avenue" monitoring station.

APPENDIX E

Electronic Files Archive

(Provided Electronically)

APPENDIX F

Application Form and Vendor Specification Sheets for Nonroad Generators

Application for Operating Non-road Engines Cumulatively >2000 Brake Horsepower: Intent to Operate

DEPARTMENT OF ECOLOGY State of Washington

I. INSTRUCTIONS

This application applies statewide for facilities under the Department of Ecology's jurisdiction. Fill out the form completely to get approval to operate non-road engines cumulatively greater than 2000 brake horsepower at one location. The fee for the approval is $95 per hour to process.

- ☐ Answer all the questions and sign and date the application.
- ☐ Provide a brief project description.
- ☐ Enclose manufacturer specification sheets with emissions data for all non-road engines.
- ☐ Enclose modeling information for National Ambient Air Quality Standard (NAAQS) compliance.
- ☐ State Environmental Policy Act (SEPA) Compliance:
  - ☐ **If SEPA review is complete** – Include a copy of the final SEPA checklist and SEPA determination (DNS, MDNS, EIS) with your application.
  - ☐ **If SEPA review is required** – – If SEPA review has not been conducted, please fill out a SEPA checklist and submit it with your application. You can find a SEPA checklist online at www.ecy.wa.gov/programs/sea/sepa/docs/echecklist.doc.
- ☐ Mail this form to the permitting authority listed below.

Check the box for the location of your proposal. For assistance, call the appropriate office listed below:

	Permitting Authority	Contact Info
☐ CRO	**Chelan, Douglas, Kittitas, Klickitat, or Okanogan County** Ecology Central Regional Office - Air Quality Program 1250 West Alder Street Union Gap, WA 98903-0009	Lynnette Haller (509) 457-7126 lynette.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 4601 N. Monroe Spokane, WA 99205-1295	Jolaine Johnson (509) 329-3452 jolaine.johnson@ecy.wa.gov
☐ NWRO	**San Juan County** Ecology Northwest Regional Office - Air Quality Program 3190 160th Ave. SE Bellevue, WA 98008-5452	David Adler (425) 649-7267 david.adler@ecy.wa.gov
☐ IND	**For actions taken at Kraft and Sulfite Paper Mills and Aluminum Smelters Only** Ecology Industrial Section P.O. Box 47600 Olympia, WA 98504-7600	James DeMay (360) 407-6868 david.demay@ecy.wa.gov
☐ NWP	**For actions taken on the US Department of Energy Hanford Reservation Only** Ecology Nuclear Waste Program 3100 Port of Benton Blvd. Richland, WA 99354	Philip Gent (509) 372-7950 philip.gent@ecy.wa.gov

II. COMPANY INFORMATION

1. Company Name: Microsoft Corporation	
2. Company Mailing Address (street, city, state, zip): 1 Microsoft Way, Redmond, WA 98052	
3. Facility Location (if different from company mailing address): 875 Urban Industrial Way, Wenatchee, WA 98802	

4. Company Contact Person, Title: Mamoudou Diallo	5. Company Phone #:	6. Company Fax #:
7. Contact Person Phone #:	8. Contact Person E-Mail Address: mamdiallo@microsoft.com	
9. On-site Plant Contact Person, Title: Mamoudou Diallo	10. On-site Plant Contact Person Phone #:	

III. GENERAL INFORMATION

1. Location of and operational information for proposed project:

Intended Dates of Operation: From: Upon approval of project To: undetermined

Site Name: East Wenatchee Data Center Campus County: Douglas

Legal Description: Quarter _____; Section _____; Township _____; Range _____

2. Provide a brief description of the project:

Two nonroad generators to be used as needed in case of failure of permanent emergency generators. One 2.0-MWe, one 1.0-MWe (two 0.5-MWe engines in one enclosure).

IV. MODELING FOR NATIONAL AMBIENT AIR QUALITY STANDARD (NAAQS) COMPLIANCE

1. Type of air model used for demonstrating NAAQS Compliance: **Please include modeling results with this application**

☐ AERSCREEN ☒ AERMOD ☐ Other: ____________________

2. Centroid distance of engines to nearest property line (feet): 219 ft

3. Fill in modeling results below:

Pollutant	Averaging Time	NAAQS	Maximum Modeled Concentration in Ambient Air*	Below NAAQS Y or N
CO	8-hr	(10 mg/m^3)	0.66 mg/m³	Y
	1-hr	(40 mg/m^3)	2.34 mg/m³	Y
NO_2	Annual	(100 µg/m^3)	33 µg/m³	Y
	1-hr	(100 ppb) or (188 µg/m^3)	Analysis not required per AQP-GUI-2010-03	N/A
PM_{10}	Annual	(50 µg/m^3)	0.27 µg/m³	Y
	24-hr	(150 µg/m^3)	25 µg/m³	Y
$PM_{2.5}$	Annual	(15.0 µg/m^3)	0.27 µg/m³	Y
	24-hr	(35 g/m^3)	2.9 µg/m³	Y

*Include maximum modeled concentration even if farther than property boundary

V. NON-ROAD ENGINE INFORMATION

1. What is the total brake horsepower rating of all non-road engines for this project?
   (Examples of non-road engines are engine powered pumps, power generators, compressors, or light towers)

   4,180 **Total brake horsepower**

All non-road engines must use ultra low sulfur diesel or ultra low sulfur bio-diesel (a sulfur content of 15 ppm or 0.0015% sulfur by weight or less), gasoline, natural gas, propane, liquefied petroleum gas (LPG), hydrogen, ethanol, methanol, or liquefied/compressed natural gas (LNG/CNG).

2. Provide manufacture specification information for each engine listed below. Please use the supplemental non-road engine information sheet if there are more than four engines.

	Engine #1	**Engine #2**
Function or purpose:		Two 0.5 MWe in one housing = 1.0-MWe
Engine manufacturer:	Caterpillar	Caterpillar
Model:	3516C	C18
Serial number:	tbd	tbd
Year of manufacture:	tbd	tbd
Fuel used:	Diesel	Diesel
Engine size:	2692 hp	744 (each 0.5-MWe) hp
Maximum hourly fuel:	126.2 gal/hr	36.5 (each 0.5-MWe) gal/hr
Height of exhaust stack:	13.4 feet	12 (one shared stack) feet
Stack velocity:	20.8 ft/sec	29.2 (one shared stack) ft/sec
Operating stack temp.:	527 °F	457 (one shared stack) °F
Stack area (inside diameter):	113.1 inches²	19.6 (one shared stack) inches²
Distance to property line:	Varies feet	Varies feet

	Engine #3	**Engine #4**
Function or purpose:		
Engine manufacturer:		
Model:		
Serial number:		
Year of manufacture:		
Fuel used:		
Engine size:	hp	hp
Maximum hourly fuel:	gal/hr	gal/hr
Height of exhaust stack:	feet	feet
Stack velocity:	ft/sec	ft/sec
Operating stack temp.:	°F	°F
Stack area (inside diameter):	inches²	inches²
Distance to property line:	feet	feet

VI. SIGNATURE BLOCK

I certify, based on information and belief formed after reasonable inquiry, the statements and information in this application are true, accurate, and complete.

Printed Name Mamoudou Diallo Title Ops. Director

Signature *Mamoudou Diallo* Date 01-19-2024

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

2.0-MWe Nonroad Generator

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]

July 19, 2023

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

PERFORMANCE DATA[EM6255]

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

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

500-KWe Nonroad Generator (2 engines in one housing to function as 1-MWe generator)

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)

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.

PERFORMANCE DATA[EM1017]

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