Application to Revise Minor Permit AQ0307MSS04

for

United States Air Force

Eareckson Air Station

Submitted To:

Alaska Department of Environmental Conservation
Division of Air Quality, Air Permits Program

Prepared By:

HMH Consulting, LLC
200 W. 34th Ave. ~ Anchorage, AK 99503
www.hmhconsulting.org

May 2020

Table of Contents

List of Tables

List of Attachments

1.0 Introduction

The United States Air Force (USAF) Eareckson Air Station (Eareckson) is requesting a series of changes to Minor Permit AQ0307MSS04 that will correct discrepancies, prevent potential compliance failures, and streamline compliance methodologies. The following requests for revision were developed following an internal quality control evaluation and a detailed on-site inspection at Eareckson in May 2019. The enclosed requests are being submitted under 18 AAC 50.508(6). The requests include:

1. Minor corrections to the emission unit inventory and addition of brake horsepower (hp) and electric kilowatt (ekW) ratings for identification purposes, along with minor additions/deletions of operating equipment, and other miscellaneous corrections to the emission unit descriptions;
2. Revision to Condition 8.2(a) to reconcile the used oil blending ratio with the blending ratio in 40 CFR 60.4216(f) and revise Condition 11.1 by adding a footnote to refer to the characteristics of used oil required by §40 CFR 60.4207;
3. Add several additional boilers to the list of available boilers in which used oil may be combusted under Conditions 8 and 10;
4. Revise the method of compliance in Condition 16.1 by replacing the current method with one that relies on tracking kilowatt-hour production using a totalizing meter.

All information required under 18 AAC 50.540(b) and (k) is included within this application. The requests contained herein will neither change any permit classifications, nor limits, nor cause any substantial changes in the facility's potential to emit (PTE). This application also includes a request to incorporate the revisions into the Title V permit by Administrative Amendment.

2.0 Minor Permit (Title I) Revision Application Requirements

This application seeks to make four changes to specific conditions of AQ0307MSS04, which are detailed individually in the sections below.

As required by 18 AAC 50.540(b), the Stationary Source Identification Form (SSID) is included in Attachment A.

In accordance with §50.540(k)(1), a copy of the Title I permit that established the permit terms and conditions that are proposed for revision is provided in Attachment B.

The remaining permit requirements listed under §50.540(k)(2)-(4) are addressed for each request in the following subsections.

2.1 Emission Unit Inventory Revision

The USAF proposes several minor revisions and corrections to the emission unit inventory in the minor permit. These changes are detailed in Tables 1 and 2, below. Deletions are

shown in ~~strikeout~~. Additions are shown in red text. A clean copy of this table, with all edits accepted, is included in Attachment C.

Table 1: Revised Emission Unit Inventory

EU ID	~~Name /~~ Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
Main Engines (DF-8 Fired (Diesel), DF-8/Used Oil (UO))					
7	3049	Engine #1, Caterpillar, Model # C280-3616, SN: NKB00320	4,600 ekW / 7,268 hp	13-Jan-2015	2013
8	3049	Engine #2, Caterpillar, Model # C280-3616, SN: NKB00317	4,600 ekW / 7,268 hp	13-Jan-2015	2013
9	3049	Engine #3, Caterpillar, Model # C280-3616, SN: NKB00315	4,600 ekW / 7,268 hp	1-Jul-2014	2013
10	3049	Engine #4, Caterpillar, Model # C280-3616 SN: NKB00316	4,600 ekW / 7,268 hp	1-Jul-2014	2013
Firewater Pump Engines (DF-8 Fired)					
13	3057	Firewater Pump #2, ~~Detroit #5~~, Clarke, Model # DDFP-04AT, SN: 4A-250901~~-7009~~ Emergency	~~186-~~188~~-~~hp	Oct. 1988	Apr. 1981
14	3057	Firewater Pump #1, ~~Detroit #6~~ Clarke, Model # DDFP-14AT SN: 4A-256080 Emergency	235 hp	Oct. 1988	Oct. 1981
15	4011	Firewater Pump, Clarke, Model # JU6H-UF-30, SN: PE6068T407586 Emergency	160 hp	Feb. 2005	Feb. 2005
16	3052	Firewater Pump ~~Unit~~ #1, Clarke, Model # JU6H-UF-30 SN: PE6068T228685 ~~JU6HUF30~~ Emergency	160 hp	2004	Jul. 2003
17	3052	Firewater Pump ~~Unit~~ #2, Clarke, Model # JU6H-UF-30 ~~JU6HUF30~~ SN: PE6068T228691 Emergency	160 hp	2004	Jul. 2003
Emergency Engines (DF-8 Fired)					
24	629	EB Generator, Cummins, Model # 4B-3.9, SN: ~~42200019,~~ 44220019 Emergency	~~62 kW~~ 66 hp	1987	Sept. 1987
27	76-558	EB Generator, Mitsubishi, Model # 4D31PT Emergency	74 hp/40 ekW	Jan. 1987	UK
30	3049~~-7~~	EB Generator, Caterpillar, Model # 3406-DI3406B, SN:~~2WB4370-~~2WBO4370 Emergency	333 hp ~~225~~/248 ekW	Jan. 1990	UK
30a	3049	EB Generator, Caterpillar, Model # C9, SN: S9L01601 Emergency	480 hp/319 ekW	2020	2007
32	4014~~-1~~	EB Generator, Mitsubishi, ~~#1,~~ Model # S6N-PTA, SN: 12939 Emergency	540 hp/350 ekW	Jan. 1991	Feb. 1989
33	4014~~-2~~	EB Generator, Mitsubishi, ~~#2~~, Model # S6N-PTA, SN: 12940 Emergency	540 hp/350 ekW	Jan. 1991	Feb. 1989

EU ID	~~Name /~~ Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
34	600	EB Generator, Caterpillar, Model # 3406B D1, SN: 2WB10512 Emergency	417 hp/283 ekW	Jan. 1991	Pre-1992
35	609	EB Generator, Cummins, Model # 6CT - 8.3, SN 44219953 Emergency	207 hp/154 ~~100~~ ekW	Jan. 1995	UK
36	754	EB Generator, Caterpillar, Model # 3412, SN 81Z04233 Emergency	665 hp/496 ~~400~~ ekW	1995	UK
~~39~~	~~110~~	~~EB Generator, Cummins, NTA855Q3, 30338752~~	~~350 kW~~	~~Jan. 1996~~	
40	628	EB Generator, Caterpillar, Model # 3400 Series ~~3406BD1~~, SN: 2WB11445 Emergency	405 hp, ~~275~~ 302 ekW	Jan. 1998	UK
41	718	EB Generator, Cummins, Model # 4BT - 3.9 Series B, SN: 44232592 Emergency	102 hp / 76.1 ~~50~~ ekW	Jan. 2000	Dec. 1987
42	775	EB Generator, Cummins, Model # VT A28 62, SN:49951 Emergency	900 hp/500 ekW	Jan. 2001	Nov. 1987
87	620	EB Generator, Volvo Penta, Model # TAD1630G, SN: 2160 033833 Emergency	672 hp / 494 ekW	2004	Pre-2004
91	585	Fermont Engine, Model # MEP-807A, SN: 100284 Emergency	134 hp / 100 kW	2018	2005
92	585	Fermont Engine, Model # MEP-807A, SN: 100165 Emergency	134 hp / 100 kW	2018	2005
Emergency Barrier Engines (DF-8-Fired)					
50a	74-041-1a	Deutz, Model # D2011L04i, SN: 11813377 – South Side	~~63.7~~ 64 hp /47.5 ekW	Mar. 2017	2012
51a	74-041-2b	Deutz, Model # D2011L04i, SN: 21508033 – North Side	~~63.7~~ 64 hp /47.5 ekW	Mar. 2017	2012
Boilers (DF-8/UO-Fired)					
54a	515	Boiler, Burnham, Model # 4FHW-107A-50-0-PF, ~~4FHW107A50.0PF,~~ SN: 1108999LB	0.716 ~~0.808~~ MMBtu/hr	Sep. 2012	-
55a	110	Boiler, Columbia SN: NB 152809 ~~B10, 636-15~~	0.8 MMBtu/hr	~~2017~~-2015	-
~~61~~	~~3045~~	~~Boiler, Burnham, 4FW-63-50-OPF, SN: 20870~~	~~0.528 MMBtu/hr~~	~~1/1994~~	-
62	600	Boiler, Cleaver Brooks, Model # ~~CB100200~~ CB100-100, SN: L-90999	4.184 MMBtu/hr	1/1994	-
63	752~~-1~~	Boiler #2, Kewanee, Catalogue # M205 KX, Order # 805371	2.05 ~~2.01~~ MMBtu/hr	1/1994	-
~~64~~	~~752-2~~	~~Boiler, Kewanee, M205KX, 801071~~	~~2.05 MMBtu/hr~~	~~1/1994~~	-
67	599	Boiler, Burnham, Model # 4FW-675A-45-0-PF, SN:18730	5.055 MMBtu/hr	2004	-
68	755	Boiler #2, Kewanee, Catalog # M 205 KX Order # 813212	2.05 MMBtu/hr	1/1995	-

EU ID	~~Name /~~ Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
70a	611	Boiler, Burnham, Model # 4FHW-180A-50-0/JP-PF, Order # 1209603LB	1.24 MMBtu/hr	~~10/17/2016~~ Jan. 1995	-
71	743~~-1~~	Boiler, Burnham, Model # 3W-100-50-0-PF, SN: 22318	3.35 MMBtu/hr	1996	-
72	743~~-2~~	Boiler, Burnham, Model # 3W-100-50-0-PF, SN: 22319	3.35 MMBtu/hr	1996	-
73	618	Boiler, Burnham, Model # 4FW-63-50-0-PF, SN: 20874	0.442 MMBtu/hr	Jan. 1998	-
74	600	Boiler #2, Cleaver Brooks, Model # CB-100-200, SN: L-83722, ~~(DF8/UO)~~	8.369 MMBtu/hr	Jan. 1998	-
75	598	Boiler, Burnham, Model # 4FW-675A-45-0-PF, SN: 18730 ~~CR4-OB-100205781~~	8.675 ~~8.657~~ MMBtu/hr	2002	-
77	729	Boiler, Weil McLain, Model # 488, SN: CP2039826	0.810 ~~0.442~~ MMBtu/hr	Unknown	-
78	755	Boiler #1, Kewanee, Catalog # 7L-280-KX, Order No 813211 ~~(DF8/UO)~~	2.66 MMBtu/hr	2004	-
79	597	Boiler #1, Burnham, Model # 4FW-240-40-0-PF, SN:19537	2.01 MMBtu/hr	2005	-
80	597	Boiler #2, Burnham, Model # 4FW-240-40-0-PF, SN: 19428	2.01 MMBtu/hr	2005	-
81	754	Boiler, Burnham, Model # 4FW-450A-50-0-PF, Natl Bd No: 28496	3.015 ~~2.65~~ MMBtu/hr	2004	-
82	754	Boiler #2, Burnham, Model # 4FW-450A-50-0-PF, Natl Bd No: 28496	3.015 ~~2.65~~ MMBtu/hr	2004	-
86	490	Boiler, Columbia, Model # WL 90, SN: 149359	1.014 MMBtu/hr	Nov. 14, 2012	-
90	743	Hot Water Boiler, PVI Industries, Model #: 500N300A-TPO SN: 39481649	0.399 MMBtu/hr	Unknown	Unknown
Microturbines					
95	585	Capstone C30 Microturbine #1	.394 MMBtu/hr	2004	2004
96	585	Capstone C30 Microturbine #2	.394 MMBtu/hr	2004	2004
97	585	Capstone C30 Microturbine #3	.394 MMBtu/hr	2004	2004
98	585	Capstone C30 Microturbine #4	.394 MMBtu/hr	2004	2004
99	585	Capstone C30 Microturbine #5	.394 MMBtu/hr	2004	2004
100	585	Capstone C30 Microturbine #6	.394 MMBtu/hr	2004	2004
101	585	Capstone C30 Microturbine #7	.394 MMBtu/hr	2004	2004
102	585	Capstone C30 Microturbine #8	.394 MMBtu/hr	2004	2004
103	585	Capstone C30 Microturbine #9	.394 MMBtu/hr	2004	2004
104	585	Capstone C30 Microturbine #10	.394 MMBtu/hr	2004	2004
105	585	Capstone C30 Microturbine #11	.394 MMBtu/hr	2004	2004
106	585	Capstone C30 Microturbine #12	.394 MMBtu/hr	2004	2004
107	585	Capstone C30 Microturbine #13	.394 MMBtu/hr	2004	2004
108	585	Capstone C30 Microturbine #14	.394 MMBtu/hr	2004	2004
109	585	Capstone C30 Microturbine #15	.394 MMBtu/hr	2004	2004

EU ID	~~Name /~~ Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
110	585	Capstone C30 Microturbine #16	.394 MMBtu/hr	2004	2004
111	585	Capstone C30 Microturbine #17	.394 MMBtu/hr	2004	2004
112	585	Capstone C30 Microturbine #18	.394 MMBtu/hr	2004	2004
Miscellaneous					
85~~a~~	Landfill ~~N/A~~	Solid Waste Landfill, Permit SW2A ~~013-20~~ 0.15-20	77,333 cubic yards	2005	-
93	729	Elastec "Smart Ash" Burn Barrel	64 lb/hr	Pre-2004	Unknown
94	729	Elastec "Smart Ash" Burn Barrel	64 lb/hr	Pre-2004	Unknown

Table 2: Inventory of Emission Units to be Removed

EU ID	Name	Description (make, model, and/or serial)	Rating/Size	Construction /Installation Date
Boilers (DF-8-Fired)				
39	110	EB Generator, Cummins, Model # NTA855Q3, SN: 30338752	350 kW	Jan. 1996
61	3045	Boiler, Burnham, Model # 4FW-63-50-OPF, SN: 20870	0.528 MMBtu/hr	1/1994
64	752-2	Boiler, Kewanee, Model # M205KX, SN: 801071	2.05 MMBtu/hr	1/1994
~~54~~	~~110-1~~	~~Boiler~~	~~0.607 MMBtu/hr~~	~~1/1982~~
~~55~~	~~110-2~~	~~Boiler~~	~~0.607 MMBtu/hr~~	~~Jan. 1992~~
~~70~~	~~611~~	~~Boiler~~	~~1.29 MMBtu/hr~~	~~1/1995~~

In accordance with §50.540(k)(2), the USAF requests these revisions to enhance its ability to correctly identify equipment in the field and prepare emission calculations or perform regulatory analyses when necessary. An internal quality review audit and on-site inspection was conducted in May 2019 which led to the recommendation to add electric kilowatt (ekW) and horsepower (hp) rating designations for electric generating engines, and other important distinguishing information, such as unit serial numbers or manufacture dates.

In accordance with §50.540(k)(3) and (4), the corrections proposed herein will have only minor effects on emissions. They will not affect other permit terms, any underlying ambient demonstrations, or compliance monitoring. The changes requested here are simple, quality assurance revisions that will lead to an agreement between the observable facts about equipment at Eareckson, and the written information contained in the permit.

Among the revisions requested in Tables 1 and 2, above, are the deletion of EU IDs 39, 61 and 64, all of which have been decommissioned.

EU IDs 30a, 87, 90, 91 and 92, 93 and 94, and 95-112 are being added as a result of being discovered in the 2019 on-site inspection. Detailed descriptions and emission calculations are provided below.

EU ID 30a is being installed as a replacement to EU ID 30. Its scheduled installation will be sometime in 2020. The unit is EPA certified (certificate manufacturer's data included in Attachment D), and its emissions represent a reduction in PTE, compared to the PTE of EU ID 30. EU ID 30 is subject to a 300 hour limit, and it is assumed that the same limit will apply to EU ID 30a. EU ID 30 is presently in operation, pending completion of the installation of EU ID 30a. These units will not operate simultaneously, beyond the commissioning period for EU ID 30a. Table Table **3**, below, illustrates the change in emissions, and detailed calculations are included on the enclosed C.D.

Table 3: Potential to Emit, Previously Unpermitted Sources, Tons per Year (TPY)

EU ID	Description	NOx	CO	SO_2	PM-10	VOC
30	EB Generator, Caterpillar, Model # 3406-DI3406B, SN: 2WBO4370 Emergency	1.5	0.3	0.1	0.1	0.1
30a	EB Generator, Caterpillar, Model # C9, SN: S9L01601 Emergency	0.7	0.1	0.1	0.01	0.02
	Change in PTE:	-0.8	-0.2	0.0	-0.09	-0.08

Notes
1. Emission factors for EU ID 30 sourced from EPA AP-42 Table 3.4-1.
2. Emission factors for EU ID 30a sourced from manufacturer's Site Variation data.
3. Emission calculations assume 300 hours of operation, annually, in accordance with Condition 15 of the Title V permit.

EU ID 87 is an existing, emergency diesel compression ignition Volvo Penta engine, which was installed in 2004, but was not previously identified by environmental personnel as a component of the emission unit inventory until the recent on-site inspection in May 2019. This unit was considered to be an insignificant emission unit (IEU) at the time that it was installed, having emissions below the thresholds described in 18 AAC 50.326(e). As such, it was not subject to an off-permit change notification at the time of its installation. In 2012, the engine ceased to qualify as an insignificant emission unit due to becoming subject to a federal standard (40 CFR 63, Subpart ZZZZ). The USAF is requesting inclusion of this unit in the Emission Unit Inventory as part of its good faith effort to ensure that the inventory is complete.

EU IDs 91 and 92 are two trailer-mounted emergency backup generators that were brought to the facility in support of a construction project by a contractor in 2018. They are expected to remain on site for about 3 years and to be operated at a single location. Thus, they cannot be considered nonroad engines. The PTE from the combined emissions of these units does not exceed the minor permit thresholds of 18 AAC 50.502(c), as shown in

Table 4, below, so the installation of these project engines did not require a minor permit to be issued prior to installation.

EU ID 90 is a hot water boiler that was discovered and added to the inventory as a result of the 2019 on-site inspection. The PTE from this unit is below the significance thresholds in 18 AAC 50.326(d).

Likewise, EU IDs 93 and 94, two Elastec Smart Ash Burn Barrels, are also below the significance thresholds. The installation dates for these three items are not known, but they have been in operation since before 2004. As insignificant emission units, no off-permit change was required at the time of installation. The units are being added to the emission unit inventory, however, as this source's emissions are subject to assessment by ADEC. With emissions below the significance thresholds of 18 AAC 50.326(d), these units also are not subject to the monitoring associated with the state emissions standards. The Potential to Emit (PTE) for these units is presented in Table Table **4**, below.

Table 4: Potential to Emit, Previously Unpermitted Sources, Tons per Year (TPY)

EU ID	Description	NOx	CO	SO_2	PM-10	VOC
87	EB Generator, Volvo Penta, Model # TAD1630G, SN: 2160 033833 Emergency	1.6	0.4	0.1	0.05	0.04
90	Hot Water Boiler, PVI Industries, Model #: 500N300A-TPO SN: 39481649	0.7	0.1	0.5	0.05	0.01
91&92	Fermont, Model # MEP-807A (combined emissions)	2.0	0.4	0.14	0.2	0.2
93	Elastec "Smart Ash" Burn Barrel	0.3	0.3	0.4	0.1	0.4
94	Elastec "Smart Ash" Burn Barrel	0.3	0.3	0.4	0.1	0.4
95-112	Capstone C30 Microturbines #1-18 (combined emissions)	5.9	0.9	9.5	0.01	0.5

Notes
1. Emission factors sources from EPA AP-42 Table 3.4-1.
2. EU ID 87 Potential to Emit (PTE) calculations based on 200 hours of operation, in accordance with "Calculating Potential to Emit (PTE) for Emergency Generators" September 6, 1995.
3. EU IDs 91 and 92 PTE calculated using 500 hours of operation.
4. Detailed calculations are included in the attached MS Excel spreadsheet.
5. Microturbine PTE calculated based on manufacturer emission data, included in Attachment E.

EU IDs 95 through 112 are a bank of 18 liquid fuel-fired microturbines, rated 0.394 MMbtu/hr, each. The group of equipment was installed in 2004. Likely construction commenced (i.e.: purchase agreement entered) prior to October 1, 2004, as construction would have been completed in the summer of 2004, prior to the promulgation of the minor permit program. Nevertheless, the combined emissions of this group of equipment is below the minor permit thresholds of 18 AAC 50.502(c), as shown in Table 4.

2.2 Reconciliation of State and Federal Requirements for Used Oil Combustion in Engines

The USAF requests to revise Condition 8.2(a) as follows:

> *"Use the WOTEC system to blend at the highest blending ratio at which the emission unit was tested and no more than 1 part used oil with ~~24~~ 57 parts DF-8 (1.75% blend ratio). "*

Also, the USAF requests to revise Condition 11.1 by adding the following footnote to the condition:

> *"For oil combusted in EU IDs 7-10, the sulfur content of the used lubricating oil must be less than 200 parts per million and the used lubricating oil must meet the on-specification levels and properties for used oil in 40 CFR 279.11 (§40 CFR 60.4207)."*

In accordance with §50.540(k)(2), the changes will result in agreement between the compliance method for the State Particulate Matter Standard (Condition 8) and the used oil blending/burning provisions that were created especially for remote Alaskan sources under 40 CFR 60.4216(f), which states:

> *The provisions of this section and §60.4207 do not prevent owners and operators of stationary CI ICE subject to this subpart that are located in remote areas of Alaska from using fuels mixed with used lubricating oil, in volumes of up to 1.75 percent of the total fuel. The sulfur content of the used lubricating oil must be less than 200 parts per million. The used lubricating oil must meet the on-specification levels and properties for used oil in 40 CFR 279.11.*

Whereas Condition 8.2(a) requires a blend ratio of 1 part used oil to 24 parts virgin fuel (4.1%), the blend ratio that is necessary to achieve compliance with §60.4216(f) is 1 part used oil to 57 parts virgin fuel (1.75%). Although USAF complies with the lower blend ratio required in §60.4216(f), the result of the recent internal quality assurance audit was a determination that the contradiction could very easily lead to a future deviation, especially given that the requirement of §60.4216(f) doesn't appear in the current Title V permit at all.

In accordance with §50.540(k)(3) and (4), there will be no effect on emissions that results from this change to the permit language. Blending used oil with virgin fuel at a ratio of 1.75% is already a requirement that is followed. Synchronizing the two requirements in the permit simply reduces the risk that someone might, in the future, blend at the incorrect ratio by following the existing language in Condition 8.2(a), which would cause non-compliance with §60.4216(f). There will be no effect on other permit terms. This request has no impact on any underlying ambient demonstration, nor does it include a change to the compliance monitoring method described in Condition 8.3(b).

2.3 Request to Add Boilers to Conditions 8.3 and 10

The USAF requests to revise Condition 8.3 as follows:

> *"8.3 Fuel Blending Requirement for all boilers listed in Table 1 (EU IDs 54a, 55a, 62-63, 67-68, 70a-75, 77-82, 86, and 90) ~~EUs 74 and 78~~*
>
> *a. Blend the used oil in the ratio of no more than 1 part used oil with 2 parts DF-8 oil…"*

The USAF requests to revise Condition 10 as follows:

> *"10. Fuel Specification. The Permittee*
>
> *10.1 shall burn only DF-8 that has the specifications of diesel fuel in all emission units except EUs 7 - 10, ~~74 and 78~~ EU IDs 54a, 55a, 62-63, 67-68, 70a-75, 77-82, 86, and 90;*
>
> *10.2 may burn used oil in EUs 7 - 10, ~~74 and 78~~ EU IDs 54a, 55a, 62-63, 67-68, 70a-75, 77-82, 86, and 90 as long as the used oil complies with the fuel blending requirements specified in*
>
> *a. Condition 8.2a for EUs 7 - 10; and*
>
> *b. Condition 8.3a for ~~EUs 74 and 78~~ EU IDs 54a, 55a, 62-63, 67-68, 70a-75, 77-82, 86, and 90."*

In accordance with §50.540(k)(2), the reason for this request is that it has become important to diversify the options for used oil disposal at Eareckson. Presently the oil filters that are used in the WOTEC system are no longer commercially available, and it is unclear whether an alternative will become available in the future. The USAF does not wish to remove the WOTEC system from its available oil blending/burning options. Although the USAF has been unsuccessful in finding compatible replacement filters, it hopes to be able to locate such supplies in the near future. In the meantime, it will be necessary to dispose of roughly 5,000 gallons per year of used oil. When blended with DF-8 at the rate described in Condition 8.3, this means a total volume of used oil/virgin fuel mixture of about 15,000 gallons per year. The available combustion capacity in EU IDs 74 and 78 is not adequate to dispose of this quantity of used oi/fuel mixture, especially if either of these units goes out of service for a period of time.

In accordance with §50.540(k)(3)(A), this request will not change the facility PTE. The estimated quantity of used oil produced at Eareckson is not expected to change as a result of this request, and the post-blend fuel sulfur content will continue to be limited to 0.3% Sulfur by weight, per Condition 11.1.

In accordance with §50.540(k)(3)(B), there are no impacts to other permit conditions that result from this request.

In accordance with §50.540(k)(3)(C), there is an underlying ambient demonstration that was conducted in 2002 as part of the PSD[1] application for this facility. The original submittal was reviewed to identify the underlying assumptions pertaining to the combustion of used oil, in an effort to ascertain what, if any, impacts to the ambient analysis might result from this request. We found that in the footnotes to Table 2-3, the applicant described used oil (therein referred to as "reclaimed oil") as follows: "Reclaimed oil = used fuel/crankcase oil mixture, 0.11% sulfur, 150,000 Btu/gallon. Maximum sulfur content 0.3% by weight used to calculate SO_2 emission rate." The assumption at the time of the modeling analysis was that used oil would contain no more than 0.11% sulfur, which equates to 1,100 ppm S by weight. Since the post-blend sulfur content is limited to 0.3% sulfur by weight in Condition 11.1 of the permit, and the sulfur content of used oil is further limited to 200 ppm by §60.4216(f), there will be no danger of exceeding the modeled impacts shown in the original modeling demonstration. The expansion of this condition to apply to all boilers on the installation will not have a deleterious effect on ambient air quality.

In accordance with §50.540(k)(3)(D), this request will result in no changes to the compliance method described in Condition 8.3(b).

In accordance with §50.540(k)(4), this request will have no effect on the facility's permit classification.

2.4 Revision to the Compliance Method in Condition 16 for EU IDs 7-10

The USAF proposes to revise the method of compliance in Condition 16 to a method that is based on the kilowatt-hours of production, and which uses no surrogate measurement to ensure compliance with the NOx limit (hours or load limit). Instead, the proposed compliance method requires calculating the rolling NOx emissions on a monthly basis using an emission factor derived from the most recent source test (100% load). This monitoring method is similar to the ones used in at least three other permitted facilities in Alaska.[2] The USAF also proposes a revised source testing scheme, which will synchronize the requirements of the source test with the revised compliance method. The USAF proposes removing existing language in 16.1(a)-(d) and replacing it with the proposed Conditions 16.2 and 16.3. The proposed permit language is as follows:

> ***16. NOx Emissions Limit.*** *The Permittee shall limit the emissions of NOx from EUs 7 - 10 to no greater than 874.2 tons in any 12 consecutive month period to avoid permit classification as a PSD major modification.*

[1] Prevention of Significant Deterioration

[2] AQ0286TVP04, AQ0348ORL01, and AQ0121ORL01

16.1 ***NOx Operating Limit.*** *To ensure compliance with the NOx emissions limit in Condition 16, the Permittee shall:*

a. *Continuously monitor the operation of EU IDs 7 through 10 using a single, totalizing kilowatt-hour (kWh) meter for the combined operation of EU IDs 7-10;*
b. *No later than the end of each calendar month calculate the total kilowatt-hours produced for the prior month and the rolling 12-month total kilowatt-hours produced from the combined operation of EU IDs 7-10;*
c. *No later than the end of each calendar month calculate the rolling 12-month total NOx emissions for the preceding 12 months by applying the emission factor of 0.021 lb/kw-hr, or using the maximum emission rate found in the most recent Department-approved source test to the 12-month rolling sum of kilowatt-hours found for each month in Condition 16.1(b);*
d. *Include the records and calculations required under Conditions 16.1 in the operating report required by the operating permit.*

The emission factor proposed above is derived from the highest emission rate found in the December 2015 source test (95.8 lb/hr, 100% load, blended fuel), and converted from a lb/hr rate to a pound per kilowatt-hour (lb/kw-hr) rate using the following equation:

$$95.8\frac{lb}{hr} \div 4{,}600\ kw = 0.021\frac{lb}{kw-hr}$$

In addition to the change in the method of compliance, the USAF proposes replacing Condition 20 (not a minor permit condition, but added to the Title V permit under the Department's "gap-filling" authority) with a reduced source testing scheme, which is intended to replace the one in the operating permit, in a new Condition 16.2, as follows:

16.2 If the 12-month rolling total NOx emissions in Condition 16.1 exceeds 874.2 tons, report as excess emissions in accordance with the operating permit.

16.3 If the 12-month rolling total NOx emissions in Condition 16.1 exceed 655.6 tons,[3] then within 180 days of discovery, conduct source tests to verify the NOx emission rate for any one of EU IDs 7 through 10.

[3] 75% of the NOx limit.

a. *Conduct the source tests at 100% load. Monitor and record the fuel consumption and average load during each test. List the average operating parameters for each run in the source test report.*

b. *Determine the NOx emission factor using exhaust properties determined by either Method 19 or Methods 1-4, for each load. If using Method 19, then use the higher heating value throughout the analysis.*

c. *Within 45 days of Department approval of the source test report, provided in accordance with Condition 16.3, calculate the 12-month rolling NOx emissions for the stationary source.*

d. *Report in the first operating report due after the source test, the newly calculated 12-month rolling NOx emissions.*

Finally, with this change, Table C of the Title V permit AQ0307TVP03, Rev. 2 should be removed as it is no longer needed when using the proposed method of compliance.

The Department should note that there was an unusual decision taken in the 2017 revision (Rev. 1) to the Title V, in which the compliance method given in the minor permit was written to reference the operating permit conditions. The operating permit conditions then reference the minor permit. What is unusual about this is that in most cases, the Department will either incorporate minor permit conditions into a Title V permit, or they will fill a compliance gap with new conditions created under its authority in 40 CFR 71.6 (the Title V process called "gap-filling"). In this case, it is unclear what the regulatory basis is for the origin of the compliance method, because both permits point at each other. The Title V permit references the minor permit as if these conditions originated from the minor, but in fact they did not. Instead, it appears that the Department created the compliance conditions through its authority for "gap-filling" (40 CFR 71.6). Therefore, choosing the correct regulatory process to make this change is somewhat uncertain. This application attempts to deal with this unusual situation by revising the minor permit conditions through the minor permit process [18 AAC 50.508(6)], and by requesting that these revisions be incorporated into the Title V by administrative amendment [40 CFR 71.6(d)(v)]. We interpret that this course of action is appropriate for addressing this change and we believe this approach will remedy what appears to be a procedural anomaly.

In accordance with §50.540(k)(2), the changes described above will relieve the USAF of a lengthy, time consuming, and difficult compliance scheme, while continuing to protect the threshold for a PSD major modification. The compliance scheme in the current minor permit relies on two surrogates to control NOx, when it is demonstrably possible, and established in the precedents set in other similar facilities across the state, to be unnecessary to create such surrogates. At the time of AQ0307TVP03, Revision 1 application (when these conditions were created) the USAF was not aware of the possibility to calculate NOx emissions directly, using the kilowatt-hour method described above. But it has been confirmed that EU IDs 7 through 10 are equipped with individual totalizing kilowatt-hour meters and with a single totalizing kilowatt-hour meter that sums the production of the four engines, combined. This information is recorded using an automated SCADA

(Supervisory control and data acquisition) system. The facility is already monitoring the combined total kilowatt-hours produced. Thus, it is technically feasible and easy to transition to this method without the need to make physical changes at the plant.

Simplifying the compliance method will have the added benefit of preventing any mistakes. The current compliance method is extremely complex. Preparation and verification of the spreadsheet used to perform the required calculations is extremely time-consuming. Complex calculation methods produced in a spreadsheet can all too easily hide errors, making the burden of maintaining this method even more taxing. Given that there are simpler methods available, and that such a method adds operational flexibility (by removing the need for an hourly or load limit), the USAF requests to revise the condition as proposed above.

In accordance with §50.540(k)(3)(A), this request will have no effect on the PTE for EU IDs 7-10. The limit is not being changed. Only the method of compliance is being changed.

In accordance with §50.540(k)(3)(B), all permit terms related to the NOx limit are being revised as part of this request. This application is being submitted simultaneously with a Title V renewal. The USAF requests an integrated review of the Title I and Title V permit applications, which will synchronize the requirements across permits (see Section 3.0). No other permit terms are affected by this request.

In accordance with §50.540(k)(3)(C), there is no underlying ambient air quality demonstration that will be affected by this request.

In accordance with §50.540(k)(3)(D) and §50.540(k)(4), this request will result in a substantial change to the compliance monitoring scheme in the permit. The effect of this request will be to reduce the burden of monitoring by simplifying the monitoring method. This in turn has the added benefit of maximizing the operational flexibility under the limit while continuing to prevent the operation of EU IDs 7-10 from exceeding the threshold for a PSD major modification.

Given that this change in the method of compliance is substantial, we have added compliance data that supports this request. The USAF has already thoroughly reviewed its present equipment and capability to comply with the method requested here. Attachment E contains a record of the last three years of actual monthly kilowatt-hour data, rolling sums, and NOx emission calculations up to December 2019. Actual NOx emissions are well below the limit of 874.2 tons, with the maximum rolling total NOx emissions of 468.65 tons, as calculated using the proposed method. EU IDs 7-10 are equipped with a totalizing kilowatt-hour meter for individual engine tracking and with a single, totalizing kilowatt-hour meter to track the combined power production of all four engines. Powerhouse personnel already collect this data on a daily basis for other purposes. Implementing and maintaining this method is, therefore, likely to be a smooth transition.

3.0 Request for Integrated Review

This application is being submitted simultaneously with the Title V renewal application for this source. The USAF requests that this application be reviewed under the integrated review produced described in 18 AAC 50.326(c)(1).

4.0 Application Fees

USAF understands that ADEC will charge fees based upon time and material for review and processing of this request under 18 AAC 50.400(h).

Alaska Department of Environmental Conservation
Air Quality Minor Permit Application

STATIONARY SOURCE IDENTIFICATION FORM

Section 1 Stationary Source Information

Name: United States Air Force, Eareckson Air Station			SIC:9711
Project Name (if different): Minor Permit Revision	Contact: Laura Junge, Air Program Manager		
Physical Address: PACAF Regional Support Center (PRSC) 9480 Pease Avenue, Suite 123 Joint Base Elmendorf-Richardson (JBER), Alaska, 99506	City: JBER	State:AK	Zip:99506
	Telephone: 907-365-9512		
	E-Mail Address: laura.junge.2.ctr@us.af.mil		
UTM Coordinates (m) or Latitude/Longitude:	Northing:	Easting:	Zone:
	Latitude: 52º 42´ 45" N	Longitude: 174º 6´ 49" W	

Section 2 Legal Owner

Name: United States Air Force		
Mailing Address: Same As Above		
City:	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 3 Operator *(if different from owner)*

Name: United States Air Force		
Mailing Address: Same As Above		
City:	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 4 Designated Agent *(for service of process)*

Name: Same as above		
Mailing Address: Same as above.		
City	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 5 Billing Contact Person *(if different from owner)*

Name: Same as above		
Mailing Address: Same as above		
City:	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 6 Application Contact

Name: Laura Junge			
Mailing Address: Same as Above	City: JBER	State: AK	Zip:99506
	Telephone (907) 365-9512		
	E-Mail Address: laura.junge.2.ctr@us.af.mil		

Section 7 Desired Process Method *(Check only one – see 18 AAC 50.542(a) for process descriptions and restrictions)*

☐ Fast track for a permit classification under 18 AAC 50.502 [18 AAC 50.542(b)]

☒ Public comment [18 AAC 50.542(d)]

Section 8 Source Classification(s) *(Check all that apply)*

[18 AAC 50.502(b)]

- ☐ Asphalt Plant [≥ 5 ton per hour]
- ☐ Thermal Soil Remediation Unit [≥ 5 ton per hour]
- ☐ Rock Crusher [≥ 5 ton per hour]
- ☐ Incinerator(s) [total rated capacity ≥ 1000 lb/hour]
- ☐ Coal Preparation Plant
- ☐ Port of Anchorage Facility

If you checked any of the above, is (are) the emission unit(s) ☐ new, ☐ relocated*, or ☐ existing?

[18 AAC 50.502(c)(1)]

New or relocated* stationary source with potential emissions greater than:

- ☐ 40 tons per year (tpy) NOx
- ☐ 40 tpy SO_2
- ☐ 15 tpy PM-10
- ☐ 10 tpy PM-2.5
- ☐ 0.6 tpy lead
- ☐ 100 tpy CO in a nonattainment area

[18 AAC 50.502(c)(2)]

Construction or relocation* of a:

- ☐ Portable oil and gas operation
- ☐ ≥ 10 MMBtu/hr fuel burning equipment in a SO_2 special protection area

* *Relocation does NOT include moving equipment from one place to another within your current stationary source boundary.*

Section 9 Modification Classification(s) (*Check all that apply)*

[18 AAC 50.502(c)(3)]

- ☐ NOx Increase > 10 tpy [and existing PTE > 40 tpy]
- ☐ SO_2 Increase > 10 tpy [and existing PTE > 40 tpy]
- ☐ PM-10 Increase > 10 tpy [and existing PTE > 15 tpy]
- ☐ PM-2.5 Increase > 10 tpy [and existing PTE > 10 tpy]
- ☐ CO Increase > 100 tpy [and existing PTE > 100 tpy in a nonattainment area]

[18 AAC 50.502(c)(4)]

- ☐ NOx Increase > 40 tpy [and existing PTE ≤ 40 tpy]
- ☐ SO_2 Increase > 40 tpy [and existing PTE ≤ 40 tpy]
- ☐ PM-10 Increase > 15 tpy [and existing PTE ≤ 15 tpy]
- ☐ PM-2.5 Increase > 10 tpy [and existing PTE ≤ 10 tpy]
- ☐ CO Increase > 100 tpy [and Existing PTE ≤ 100 tpy in a nonattainment area]

Basis for calculating modification:

- ☐ Projected actual emissions minus baseline actual emissions
- ☐ New potential emissions minus existing potential emissions

Section 10 Permit Action Request (*Check all that apply)*

[18 AAC 50.508]

- ☐ Establish Plant-wide Applicability Limitation (PAL)
- ☐ Establish emission reductions to offset nonattainment pollutant
- ☐ Owner Requested Limit* (ORL)
- ☒ Revise or Rescind Title I Permit Conditions *
  Permit Number: AQ0307MSS04 Condition No. 8, 10, 11, 16
  Date: January 2020

**Which to use? See* http://www.dec.state.ak.us/air/ap/docs/orlrtc.pdf

Section 11 Existing Permits and Limits

For an existing stationary source, do you have an existing:
(Check all that apply)

- ☒ Air quality permit Number(s)*: AQ0307TVP03, Rev. 2
  AQ0307MSS04

- ☐ Owner Requested Limit(s) Permit Number(s):
- ☐ Pre-Approved Emission Limit (PAEL) Number(s)**:

** All active construction, Title V, and minor permit numbers.*
***Optional. Please provide this number if possible.*
http://dec.alaska.gov/Applications/Air/airtoolsweb/

Section 12 Project Description

Provide a short narrative describing the project. Discuss the purpose for conducting this project, what emission units/activities will be added/modified under this project (i.e., project scope), and the project timeline. If the project is a modification to an existing stationary source, describe how this project will affect the existing process. Include any other discussion that may assist the Department in understanding your project or processing your application. Include a schedule of construction.

Please use additional copies of this sheet if necessary.

The United States Air Force (USAF) Eareckson Air Station (Eareckson) is requesting a series of changes to Minor Permit AQ0307MSS04 that will correct discrepancies, prevent compliance failures, and streamline compliance methodologies. The following requests for revision were developed following an internal quality control evaluation and a detailed on-site inspection at Eareckson in May 2019. The enclosed requests are being submitted under 18 AAC 50.508(6). The requests include:

1. Minor corrections to the emission unit inventory and addition of brake horsepower (hp) and electric kilowatt (kWe) ratings for identification purposes, along with minor additions/deletions of operating equipment, and other miscellaneous corrections to the emission unit descriptions;
2. Revision to Condition 8.2(a) to reconcile the blend ratio with the blend ratio in 40 CFR 60.4216(f) and revise Condition 11.1 by adding a footnote to refer to the characteristics of used oil required by §40 CFR 60.4207;
3. Add several additional boilers to the list of available boilers in which used oil may be combusted under Condition 8.4;
4. Revise the method of compliance in Condition 16.1(d) by replacing the current method with one that relies on tracking kilowatt-hour production using a totalizing meter.

All information required under 18 AAC 50.540(b) and (k) is included within this application. The requests contained herein will neither change any permit classifications, nor limits, nor cause any substantial changes in the facility's potential to emit (PTE). This application also includes a request to incorporate the revisions into the Title V permit by Administrative Amendment.

Section 12 Project Description Continued

For **PALs under Section 10** of this application, include the information listed in 40 C.F.R. 52.21(aa)(3), adopted by reference in 18 AAC 50.040 [18 AAC 50.540(h)].

NA

For a **limit to establish offsetting emissions under Section 10** of this application, specify the physical or operational limitations necessary to provide actual emission reductions of the nonattainment air pollutant; including [18 AAC 50.540(i)]:

- A calculation of the expected reduction in actual emissions; and

  NA

- The emission limitation representing that quantity of emission reduction.

  NA

Section 12 Project Description Continued

For **ORLs under Section 10** of this application [18 AAC 50.540(j)], include:

A description of each proposed limit, including for each air pollutant a calculation of the effect the limit will have on the stationary source's potential to emit and the allowable emissions [18 AAC 50.225(b)(4)];

NA

A description of a verifiable method to attain and maintain each limit, including monitoring and recordkeeping requirements [18 AAC 50.225(b)(5)];

NA

Citation to each requirement that the person seeks to avoid, including an explanation of why the requirement would apply in the absence of the limit and how the limit allows the person to avoid the requirement [18 AAC 50.225(b)(6)];

NA

A statement that the owner or operator of the stationary source will be able to comply with each limit [18 AAC 50.225(b)(8)];

NA

Section 12 Project Description Continued

For **revising or rescinding Title I permit conditions under Section 10** of this application [18 AAC 50.540(k)], include:

An explanation of why the permit term or condition should be revised or rescinded [18 AAC 50.540(k)(2)];

Please refer to attached application narrative.

The effect of revising or revoking the permit term or condition on [18 AAC 50. 540 (k)(3)]:

- Emissions;
  Please refer to attached application narrative.

- Other permit terms;
  Please refer to attached application narrative.

- The underlying ambient demonstration, if any;
  Please refer to attached application narrative.

- Compliance monitoring; and
  Please refer to attached application narrative.

For revising a condition that allows avoidance of a permit classification, the information required for that type of permit, unless the revised condition would also allow the owner or operator to avoid the classification. [18 AAC 50.540(k)(4)]

Please refer to attached application narrative.

Section 13 Other Application Material

The information listed below must be included in your air quality control minor permit application. *Note: These must be attached in order for your application to be complete.*

If required to submit an analysis of ambient air quality under 18 AAC 50.540(c)(2), or if otherwise requested by the Department:

☐ Attached are maps, plans, and/or aerial photographs as necessary to show the locations and distances of
- emissions units, buildings, emitting activities and boundaries of the associated with the stationary source, and
- nearby or adjacent residences, roads, other occupied structures and general topography within 15 kilometers.

(Indicate compass direction and scale on each.)

☐ Attached is a document (e.g., spreadsheet) showing coordinates and elevations of each modeled unit, along with parameters necessary to characterize each unit for dispersion modeling.

☐ Attached is an electronic copy of all modeling files.

Section 14 Certification

This certification applies to the Air Quality Control Minor Permit Application for the Eareckson Air Station submitted to the Department on: _____.
(Stationary Source Name)

Type of Application

☒ Initial Application

☐ Change to Initial Application

The application is **NOT** complete unless the certification of truth, accuracy, and completeness on this form bears the signature of a **Responsible Official**. Responsible Official is defined in 18 AAC 50.990. (18 AAC 50.205)

CERTIFICATION OF TRUTH, ACCURACY, AND COMPLETENESS

"Based on information and belief formed after reasonable inquiry, I certify that the statements and information in and attached to this document are true, accurate, and complete."

Signature: CORNWELL.PAUL.S.1027493706 Digitally signed by CORNWELL.PAUL.S.1027493706 Date: 2020.07.27 13:48:58 -08'00'	Date:
Printed Name: Paul S. Cornwell	Title: PRSC Commander

Section 15 Attachments

☒ Attachments Included. List attachments:

Application Narrative
Minor Permit AQ0307MSS04
Kilowatt-hour production data (2017-2019) and NOx emission calculations

Section 16 Mailing Address

Submit the minor permit application to the Permit Intake Clerk in the Department's Anchorage office. Submitting to a different office will delay processing. The mailing address and phone number for the Anchorage office is:

Permit Intake Clerk
Alaska Department of Environmental Conservation
Air Permit Program
555 Cordova Street
Anchorage, Alaska 99501
(907) 269-6881

Clean Copy of Emission Unit Inventory Table

The following table is the same as shown in Table 1 of this application, except all editing annotations have been accepted. This is a clean copy of the Emission Unit Inventory Table.

EU ID	Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
Main Generators (DF-8 Fired, DF-8/UO)					
7	3049	Engine #1, Caterpillar, Model # C280-3616, SN: NKB00320	4,600 ekW / 7,268 hp	13-Jan-2015	2013
8	3049	Engine #2, Caterpillar, Model # C280-3616, SN: NKB00317	4,600 ekW / 7,268 hp	13-Jan-2015	2013
9	3049	Engine #3, Caterpillar, Model # C280-3616, SN: NKB00315	4,600 ekW / 7,268 hp	1-Jul-2014	2013
10	3049	Engine #4, Caterpillar, Model # C280-3616 SN: NKB00316	4,600 ekW / 7,268 hp	1-Jul-2014	2013
Firewater Pump Engines (DF-8 Fired)					
13	3057	Firewater Pump #2, Clarke, Model # DDFP-04AT, SN: 4A-250901 Emergency	188-hp	Oct. 1988	Apr. 1981
14	3057	Firewater Pump #1, Clarke, Model # DDFP-14AT SN: 4A-256080 Emergency	235 hp	Oct. 1988	Oct. 1981
15	4011	Firewater Pump, Clarke, Model # JU6H-UF-30, SN: PE6068T407586 Emergency	160 hp	Feb. 2005	Feb. 2005
16	3052	Firewater Pump Clarke, Model # JU6H-UF-30 SN: PE6068T228685 Emergency	160 hp	2004	Jul. 2003
17	3052	Firewater Pump #2, Clarke, Model # JU6H-UF-30 SN: PE6068T228691 Emergency	160 hp	2004	Jul. 2003
Emergency Generators (DF-8 Fired)					
24	629	EB Generator, Cummins, Model # 4B-3.9, SN: 44220019 Emergency	66 hp	1987	Sept. 1987
27	76-558	EB Generator, Mitsubishi, Model # 4D31PT Emergency	74 hp/40 eKw	Jan. 1987	NA
30	3049	EB Generator, Caterpillar, Model # 3406-DI3406B, SN: 2WBO4370 Emergency	333 hp /248 ekW	Jan. 1990	NA
30a	3049	EB Generator, Caterpillar, Model # C9, SN: S9L01601 Emergency	480 hp/319 ekW	2020	2007
32	4014	EB Generator, Mitsubishi, Model # S6N-PTA, SN: 12939 Emergency	540 hp/350 ekW	Jan. 1991	Feb. 1989
33	4014	EB Generator, Mitsubishi, Model # S6N-PTA, SN: 12940 Emergency	540 hp/350 ekW	Jan. 1991	Feb. 1989
34	600	EB Generator, Caterpillar, Model # 3406B D1, SN: 2WB10512 Emergency	417 hp/283 ekW	Jan. 1991	Pre-1992

EU ID	Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
35	609	EB Generator, Cummins, Model # 6CT - 8.3, SN 44219953 Emergency	207 hp/154 ekW	Jan. 1995	NA
36	754	EB Generator, Caterpillar, Model # 3412, SN 81Z04233 Emergency	665 hp/496 ekW	1995	NA
40	628	EB Generator, Caterpillar, Model # 3400 Series, SN: 2WB11445 Emergency	405 hp, 302 ekW	Jan. 1998	NA
41	718	EB Generator, Cummins, Model # 4BT - 3.9 Series B, SN: 44232592 Emergency	102 hp /76.1 ekW	Jan. 2000	Dec. 1987
42	775	EB Generator, Cummins, Model # VT A28 62, SN:49951 Emergency	900 hp/500 ekW	Jan. 2001	Nov. 1987
87	620	EB Generator, Volvo Penta, Model # TAD1630G, SN: 2160 033833 Emergency	672 hp / 494 ekW	2004	
91	585	Fermont Engine, Model # MEP-807A, SN: 100284 Emergency	134 hp / 100 kW	2018	2005
92	585	Fermont Engine, Model # MEP-807A, SN: 100165 Emergency	134 hp / 100 kW	2018	2005
Emergency Barrier Engines (DF-8-Fired)					
50a	74-041-1a	Deutz Engine, Model # D2011L04i, SN: 11813377 – South Side	64 hp /47.5 ekW	Mar. 2017	2012
51a	74-041-2b	Deutz Engine, Model # D2011L04i, SN: 21508033 – North Side	64 hp /47.5 ekW	Mar. 2017	2012
Boilers (DF-8/UO-Fired)					
54a	515	Boiler, Burnham, Model # 4FHW-107A-50-0-PF, SN: 1108999LB	0.716 MMBtu/hr	Sep. 2012	-
55a	110	Boiler, Columbia SN: NB 152809	0.8 MMBtu/hr	2015	-
62	600	Boiler, Cleaver Brooks, Model # CB100-100, SN: L-90999	4.184 MMBtu/hr	1/1994	-
63	752	Boiler #2, Kewanee, Catalogue # M205 KX, Order # 805371	2.05 MMBtu/hr	1/1994	-
67	599	Boiler, Burnham, Model # 4FW-675A-45-0-PF, SN:18730	5.055 MMBtu/hr	2004	-
68	755	Boiler #2, Kewanee, Catalog # M 205 KX Order # 813212	2.05 MMBtu/hr	1/1995	-
70a	611	Boiler, Burnham, Model # 4FHW-180A-50-0/JP-PF, Order # 1209603LB	1.24 MMBtu/hr	Jan. 1995	-
71	743	Boiler, Burnham, Model # 3W-100-50-0-PF, SN: 22318	3.35 MMBtu/hr	1996	-
72	743	Boiler, Burnham, Model # 3W-100-50-0-PF, SN: 22319	3.35 MMBtu/hr	1996	-
73	618	Boiler, Burnham, Model # 4FW-63-50-0-PF, SN: 20874	0.442 MMBtu/hr	Jan. 1998	-
74	600	Boiler #2, Cleaver Brooks, Model # CB-100-200, SN: L-83722	8.369 MMBtu/hr	Jan. 1998	-

EU ID	Bldg. No.	Description (make, model, and/or serial)	Rating/Size	Const./ Install Date	Model Year
75	598	Boiler, Burnham, Model # 4FW-675A-45-0-PF, SN: 18730	8.675 MMBtu/hr	2002	-
77	729	Boiler, Weil McLain, Model # 488, SN: CP2039826	0.810 MMBtu/hr	Unknown	-
78	755	Boiler #1, Kewanee, Catalog # 7L-280-KX, Order No 813211	2.66 MMBtu/hr	2004	-
79	597	Boiler #1, Burnham, Model # 4FW-240-40-0-PF, SN:19537	2.01 MMBtu/hr	2005	-
80	597	Boiler #2, Burnham, Model # 4FW-240-40-0-PF, SN: 19428	2.01 MMBtu/hr	2005	-
81	754	Boiler, Burnham, Model # 4FW-450A-50-0-PF, Natl Bd No: 28496	3.015 MMBtu/hr	2004	-
82	754	Boiler #2, Burnham, Model # 4FW-450A-50-0-PF, Natl Bd No: 28496	3.015 MMBtu/hr	2004	-
86	490	Boiler, Columbia, Model # WL 90, SN: 149359	1.014 MMBtu/hr	Nov. 14, 2012	-
90	743	Hot Water Boiler, PVI Industries, Model #: 500N300A-TPO SN: 39481649	0.399 MMBtu/hr	Unknown	Unknown
Microturbines					
95	585	Capstone C30 Microturbine #1	.394 MMBtu/hr	2004	2004
96	585	Capstone C30 Microturbine #2	.394 MMBtu/hr	2004	2004
97	585	Capstone C30 Microturbine #3	.394 MMBtu/hr	2004	2004
98	585	Capstone C30 Microturbine #4	.394 MMBtu/hr	2004	2004
99	585	Capstone C30 Microturbine #5	.394 MMBtu/hr	2004	2004
100	585	Capstone C30 Microturbine #6	.394 MMBtu/hr	2004	2004
101	585	Capstone C30 Microturbine #7	.394 MMBtu/hr	2004	2004
102	585	Capstone C30 Microturbine #8	.394 MMBtu/hr	2004	2004
103	585	Capstone C30 Microturbine #9	.394 MMBtu/hr	2004	2004
104	585	Capstone C30 Microturbine #10	.394 MMBtu/hr	2004	2004
105	585	Capstone C30 Microturbine #11	.394 MMBtu/hr	2004	2004
106	585	Capstone C30 Microturbine #12	.394 MMBtu/hr	2004	2004
107	585	Capstone C30 Microturbine #13	.394 MMBtu/hr	2004	2004
108	585	Capstone C30 Microturbine #14	.394 MMBtu/hr	2004	2004
109	585	Capstone C30 Microturbine #15	.394 MMBtu/hr	2004	2004
110	585	Capstone C30 Microturbine #16	.394 MMBtu/hr	2004	2004
111	585	Capstone C30 Microturbine #17	.394 MMBtu/hr	2004	2004
112	585	Capstone C30 Microturbine #18	.394 MMBtu/hr	2004	2004
Miscellaneous					
85	Landfill	Solid Waste Landfill, Permit SW2A 0.13-20	77,333 cubic yards	2005	-
93	729	Elastec “Smart Ash” Burn Barrel	64 lb/hr	Unknown	Unknown
94	729	Elastec “Smart Ash” Burn Barrel	64 lb/hr	Unknown	Unknown

PERFORMANCE DATA[DM8168]

January 23, 2020

Performance Number: DM8168 **Change Level: 04**

SALES MODEL:	C9	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	480	**HERTZ:**	60
GEN POWER W/O FAN (EKW):	319.0	**FAN POWER (HP):**	36.5
GEN POWER WITH FAN (EKW):	300.0	**ASPIRATION:**	TA
COMPRESSION RATIO:	16.1	**AFTERCOOLER TYPE:**	ATAAC
RATING LEVEL:	STANDBY	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
PUMP QUANTITY:	1	**INLET MANIFOLD AIR TEMP (F):**	120
FUEL TYPE:	DIESEL	**JACKET WATER TEMP (F):**	192.2
MANIFOLD TYPE:	DRY	**TURBO CONFIGURATION:**	SINGLE
GOVERNOR TYPE:	ELEC	**TURBO QUANTITY:**	1
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	S310-1.25
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2005
INJECTOR TYPE:	EUI	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	1,759.8
REF EXH STACK DIAMETER (IN):	4		
MAX OPERATING ALTITUDE (FT):	3,281		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	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
300.0	100	480	393	0.332	22.7	82.5	122.6	1,247.3	60.6	927.2
270.0	90	430	352	0.334	20.5	78.7	121.1	1,179.5	55.9	877.6
240.0	80	383	314	0.339	18.5	74.9	121.5	1,120.8	51.5	840.4
225.0	75	361	295	0.342	17.6	73.0	121.6	1,094.5	49.4	826.3
210.0	70	339	277	0.347	16.8	71.0	121.7	1,071.1	47.3	817.6
180.0	60	296	242	0.360	15.2	66.4	121.7	1,028.3	43.1	800.8
150.0	50	253	207	0.376	13.6	61.1	121.7	988.0	38.7	784.5
120.0	40	212	173	0.390	11.8	52.8	121.7	944.9	32.8	768.7
90.0	30	170	139	0.403	9.8	42.5	121.6	899.1	25.9	752.9
75.0	25	149	122	0.411	8.7	36.9	121.6	875.4	22.3	745.0
60.0	20	127	104	0.419	7.6	30.8	121.6	850.8	18.7	737.0
30.0	10	82.9	68	0.441	5.2	17.9	121.5	723.0	11.7	650.3

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW 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
300.0	100	480	83	450.8	916.6	2,460.9	3,985.8	4,144.9	872.5	798.0
270.0	90	430	80	428.0	893.4	2,306.9	3,884.5	4,028.0	848.2	780.6
240.0	80	383	76	406.4	870.9	2,173.0	3,772.3	3,902.1	821.8	760.2
225.0	75	361	74	396.1	859.8	2,109.4	3,711.7	3,835.1	806.5	747.8
210.0	70	339	72	386.3	846.8	2,047.1	3,649.5	3,766.9	788.0	732.2
180.0	60	296	67	367.7	814.1	1,926.8	3,499.4	3,605.2	751.6	701.1
150.0	50	253	62	350.2	772.8	1,810.5	3,315.8	3,410.8	715.5	669.7
120.0	40	212	54	321.8	707.1	1,643.7	3,018.0	3,100.6	657.9	617.9
90.0	30	170	43	282.8	623.3	1,424.8	2,642.8	2,711.5	577.7	544.3
75.0	25	149	38	260.3	576.0	1,299.8	2,434.3	2,495.5	530.5	500.6
60.0	20	127	31	235.4	524.5	1,162.9	2,209.5	2,262.9	477.8	451.6
30.0	10	82.9	18	178.8	412.8	851.2	1,728.1	1,764.7	377.1	358.8

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY

PERFORMANCE DATA[DM8168]

January 23, 2020

EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
300.0	100	480	6,838	1,312	18,223	10,196	2,598	5,239	20,357	48,785	51,968
270.0	90	430	6,227	1,100	16,530	8,999	2,344	4,774	18,249	44,009	46,881
240.0	80	383	5,718	954	15,163	8,062	2,120	4,304	16,263	39,804	42,402
225.0	75	361	5,492	885	14,576	7,680	2,017	4,080	15,306	37,868	40,339
210.0	70	339	5,288	827	14,082	7,393	1,922	3,868	14,366	36,078	38,432
180.0	60	296	4,912	823	13,054	6,800	1,739	3,448	12,536	32,644	34,774
150.0	50	253	4,565	786	11,966	6,184	1,555	3,034	10,749	29,195	31,100
120.0	40	212	4,219	770	10,567	5,402	1,348	2,419	8,983	25,307	26,959
90.0	30	170	3,811	699	8,973	4,534	1,120	1,706	7,210	21,028	22,400
75.0	25	149	3,554	623	8,129	4,085	999	1,352	6,312	18,747	19,970
60.0	20	127	3,271	492	7,247	3,625	871	1,008	5,399	16,350	17,417
30.0	10	82.9	2,624	519	4,878	2,172	597	397	3,514	11,200	11,931

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**300.0**	**225.0**	**150.0**	**75.0**	**30.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**480**	**361**	**253**	**149**	**82.9**
TOTAL NOX (AS NO2)		G/HR	2,032	1,047	539	288	217
TOTAL CO		G/HR	214	166	242	203	191
TOTAL HC		G/HR	50	54	81	76	65
PART MATTER		G/HR	30.2	29.7	66.7	43.9	28.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,371.7	1,572.5	1,056.2	887.0	1,244.7
TOTAL CO	(CORR 5% O2)	MG/NM3	216.0	218.7	414.7	579.4	974.9
TOTAL HC	(CORR 5% O2)	MG/NM3	43.7	62.4	119.7	182.7	276.3
PART MATTER	(CORR 5% O2)	MG/NM3	24.8	34.3	101.8	98.2	126.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,155	766	514	432	606
TOTAL CO	(CORR 5% O2)	PPM	173	175	332	464	780
TOTAL HC	(CORR 5% O2)	PPM	82	116	223	341	516
TOTAL NOX (AS NO2)		G/HP-HR	4.27	2.92	2.13	1.94	2.61
TOTAL CO		G/HP-HR	0.45	0.46	0.96	1.36	2.30
TOTAL HC		G/HP-HR	0.11	0.15	0.32	0.51	0.79
PART MATTER		G/HP-HR	0.06	0.08	0.26	0.29	0.34
TOTAL NOX (AS NO2)		LB/HR	4.48	2.31	1.19	0.64	0.48
TOTAL CO		LB/HR	0.47	0.37	0.53	0.45	0.42
TOTAL HC		LB/HR	0.11	0.12	0.18	0.17	0.14
PART MATTER		LB/HR	0.07	0.07	0.15	0.10	0.06

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**300.0**	**225.0**	**150.0**	**75.0**	**30.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**480**	**361**	**253**	**149**	**82.9**
TOTAL NOX (AS NO2)		G/HR	1,881	970	499	267	201
TOTAL CO		G/HR	115	89	129	109	102
TOTAL HC		G/HR	26	29	43	40	35
TOTAL CO2		KG/HR	225	175	135	86	51
PART MATTER		G/HR	15.5	15.2	34.2	22.5	14.6
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,196.0	1,456.1	978.0	821.3	1,152.5
TOTAL CO	(CORR 5% O2)	MG/NM3	115.5	117.0	221.7	309.8	521.3
TOTAL HC	(CORR 5% O2)	MG/NM3	23.1	33.0	63.3	96.7	146.2
PART MATTER	(CORR 5% O2)	MG/NM3	12.7	17.6	52.2	50.4	64.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,070	709	476	400	561
TOTAL CO	(CORR 5% O2)	PPM	92	94	177	248	417
TOTAL HC	(CORR 5% O2)	PPM	43	62	118	180	273
TOTAL NOX (AS NO2)		G/HP-HR	3.95	2.70	1.98	1.79	2.42
TOTAL CO		G/HP-HR	0.24	0.25	0.51	0.73	1.23
TOTAL HC		G/HP-HR	0.06	0.08	0.17	0.27	0.42
PART MATTER		G/HP-HR	0.03	0.04	0.14	0.15	0.18
TOTAL NOX (AS NO2)		LB/HR	4.15	2.14	1.10	0.59	0.44
TOTAL CO		LB/HR	0.25	0.20	0.29	0.24	0.22
TOTAL HC		LB/HR	0.06	0.06	0.09	0.09	0.08
TOTAL CO2		LB/HR	496	387	297	189	112
PART MATTER		LB/HR	0.03	0.03	0.08	0.05	0.03
OXYGEN IN EXH		%	9.2	11.2	12.6	13.6	15.0
DRY SMOKE OPACITY		%	0.3	0.4	1.0	0.8	0.8
BOSCH SMOKE NUMBER			0.07	0.20	0.90	0.76	0.68

Regulatory Information

EPA TIER 3		2005 - 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 3	CO: 3.5 NOx + HC: 4.0 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: 4.0 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	480	480	480	480	480	477	474	465	452	433	412	395	478
1,000	480	480	480	480	477	475	470	457	441	422	402	386	476
2,000	480	480	479	477	474	470	463	446	427	410	392	376	473
3,000	480	478	475	470	463	457	449	434	418	403	386	370	464
4,000	475	469	463	456	450	444	436	422	407	391	374	358	453
5,000	462	456	449	442	436	430	422	408	393	377	360	343	442
6,000	449	442	435	428	422	416	408	394	379	362	346	329	430
7,000	434	428	421	414	408	402	394	379	364	348	332	315	418
8,000	420	413	406	400	394	387	380	365	350	334	318	302	406
9,000	405	398	392	385	379	373	365	350	335	320	305	289	394
10,000	390	384	377	371	365	359	352	337	322	307	293	278	382
11,000	376	369	363	357	351	345	339	334	320	305	291	277	370
12,000	361	355	348	342	337	331	326	320	315	303	288	270	357
13,000	347	340	334	329	323	318	312	307	302	290	274	257	345
14,000	332	326	321	315	310	304	299	294	289	276	261	246	333
15,000	319	313	307	302	297	291	286	282	276	263	249	235	322

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K6616	NAP	2531644	GS279	-	S9L00001	
4150068	PP5547	3950369	GS279	-	S9P00001	
4150068	PP5547	4529865	GS857	LS	S9P00001	
4150068	PP5547	5664658	PG350	G	RG300001	
4150068	PP5547	5664658	PG375	G	RE300001	

Performance Parameter Reference

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

PERFORMANCE DATA[DM8168]

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

CATERPILLAR

Engine Emissions Data

For Emissions / Certification feedback and questions, please submit a ticket via our ERC Request Portal

This emission data is Caterpillar's best estimate for this rating. If actual emissions are required then an emission test needs to be run on your engine.

Serial Number (Machine)	C9E00872
Serial Number (Engine)	**S9L01601**
Sales Model	C9
Regulatory Build Date	20-DEC-2007
As Shipped Data	
Engine Arrangement Number	2531644
Certification Arrangement	2801098
Test Spec Number	0K6616
Regulatory Status	EPA/CARB @ Constant speed
EPA Family Code	7CPXL08.8ESK
EPA Emissions Level	EPA Tier 3
Current Flash file	2775708
Flash File Progression	5781990
CORR FL Power at RPM	480 HP (358.0 KW)1800 RPM
Advertised Power	480 HP 1,800RPM
Total Displacement	8.8 L

Disclaimer: The information provided has been compiled from third party sources and is accurate to the best of Caterpillar's knowledge. However, Caterpillar cannot guarantee the accuracy, completeness, or validity of the information and is not liable for any errors or omissions contained therein. All information provided should be independently verified and confirmed, including by examining the emissions label located on the engine.

Need emission replacement label? Click here!

California Environmental Protection Agency AIR RESOURCES BOARD	CATERPILLAR, INC.	EXECUTIVE ORDER U-R-001-0304 New Off-Road Compression-Ignition Engines

Pursuant to the authority vested in the Air Resources Board by Sections 43013, 43018, 43101, 43102, 43104 and 43105 of the Health and Safety Code; and

Pursuant to the December 15, 1998 Settlement Agreement between the Air Resources Board and the manufacturer, and any modifications thereof to the Settlement Agreement;

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-02-003;

IT IS ORDERED AND RESOLVED: That the following compression-ignition engine and emission control system produced by the manufacturer are certified as described below for use in off-road equipment. Production engines shall be in all material respects the same as those for which certification is granted.

MODEL YEAR	ENGINE FAMILY	DISPLACEMENT (liters)	FUEL TYPE	USEFUL LIFE (hours)
2007	7CPXL08.8ESK	8.8	Diesel	8000

SPECIAL FEATURES & EMISSION CONTROL SYSTEMS	TYPICAL EQUIPMENT APPLICATION
Direct Diesel Injection, Turbocharger, Charge Air Cooler and Engine Control Module	Tractor, Dozer, Generator and Industrial Equipment

The engine models and codes are attached.

The following are the exhaust certification standards (STD) and certification levels (CERT) for hydrocarbon (HC), oxides of nitrogen (NOx), or non-methane hydrocarbon plus oxides of nitrogen (NMHC+NOx), carbon monoxide (CO), and particulate matter (PM) in grams per kilowatt-hour (g/kw-hr), and the opacity-of-smoke certification standards and certification levels in percent (%) during acceleration (Accel), lugging (Lug), and the peak value from either mode (Peak) for this engine family (Title 13, California Code of Regulations, (13 CCR) Section 2423):

RATED POWER CLASS	EMISSION STANDARD CATEGORY		EXHAUST (g/kw-hr)					OPACITY (%)		
			HC	NOx	NMHC+NOx	CO	PM	ACCEL	LUG	PEAK
130 ≤ KW < 450	Tier 3	STD	N/A	N/A	4.0	3.5	0.20	20	15	50
		CERT	--	--	3.7	3.1	0.15	16	3	24

BE IT FURTHER RESOLVED: That for the listed engine models, the manufacturer has submitted the information and materials to demonstrate certification compliance with 13 CCR Section 2424 (emission control labels), and 13 CCR Sections 2425 and 2426 (emission control system warranty).

Engines certified under this Executive Order must conform to all applicable California emission regulations.

This Executive Order is only granted to the engine family and model-year listed above. Engines in this family that are produced for any other model-year are not covered by this Executive Order.

Executed at El Monte, California on this 11th day October 2006.

Annette Hebert, Chief
Mobile Source Operations Division

ATTACHMENT 1 OF 1

Engine Model Summary Form

Manufacturer: **CATERPILLAR INC.**

Engine category: **Nonroad Over 50 Hp**

EPA Engine Family: **7CPXL08.8ESK**

Mfr Family Name: **NA**

Process Code: **New Submission**

U-R-001-0304

1.Engine Code	2.Engine Model	3.BHP@RPM (SAE Gross)	4.Fuel Rate: mm/stroke @ peak HP (for diesel only)	5.Fuel Rate: (lbs/hr) @ peak HP (for diesels only)	6.Torque @ RPM (SEA Gross)	7.Fuel Rate: mm/stroke@peak torque	8.Fuel Rate: (lbs/hr)@peak torque	9.Emission Control Device Per SAE J1930
1 Cert Engine	C9	375@1800	209	126.5	1250@1400	246	116.0	EM.DI,TC,ECM,CAC
2	C9	330@2100	168	118	1173@1400	227	107	EM, DI, TC, ECM,
3	C9	289@2000	153	103	885@1400	181	85	EM, DI, TC, ECM,
4	C9	258@2000	138	93	795@1400	162	76	EM, DI, TC, ECM,
5	C9	350@2100	178	125.4	1029@1400	208	98.1	EM, DI, TC, ECM,
6	C9	228@1850	136	84.5	852@1300	185	80.7	EM, DI, TC, ECM,
7	C9	325@2200	162	119.6	1095@1400	222	104.6	EM, DI, TC, ECM,
8	C9	330@2100	176	124.6	1173@1400	235	110.8	EM, DI, TC, ECM,
9	C9	311@2100	166	117.0	1106@1400	231	109.0	EM, DI, TC, ECM,
10	C9	278@2100	147	104.0	988@1400	204	96.0	EM, DI, TC, ECM,
11	C9	311@2100	163	115.0	1098@1400	226	106.0	EM, DI, TC, ECM,
12	C9	275@2200	139	103.0	927@1400	186	103.0	EM, DI, TC, ECM,
13	C9	300@2200	149	110.0	1011@1400	200	110.0	EM, DI, TC, ECM,
14	C9	350@2200	173	128.0	1148@1400	234	110.0	EM, DI, TC, ECM,
15	C9	261@1800	153	93..0	915@1400	187	88.0	EM, DI, TC, ECM,
16	C9	286@1800	167	101.0	1000@1400	203	96.0	EM, DI, TC, ECM,
17 Cert Engine	C9	480@1800	265	160.0	NA	NA	NA	EM, DI, TC, ECM,
18	C9	480@1800	265	160.0	NA	NA	NA	EM, DI, TC, ECM,
19	C9	398@1800	226	137.0	NA	NA	NA	EM, DI, TC, ECM,
20	C9	374@1800	209	127.0	NA	NA	NA	EM, DI, TC, ECM,
21	C9	386@1500	253	127.0	NA	NA	NA	EM, DI, TC, ECM,
22	C9	373@1500	245	124.0	NA	NA	NA	EM, DI, TC, ECM,
23	C9	480@1800	265	160.0	NA	NA	NA	EM, DI, TC, ECM,
24	C9	398@1800	226	137.0	NA	NA	NA	EM, DI, TC, ECM,
25	C9	480@1800	265	160.0	NA	NA	NA	EM, DI, TC, ECM,
26	C9	374@1800	209	127.0	NA	NA	NA	EM, DI, TC, ECM,
27	C9	286@2000	155	104.0	885@1400	184	87.0	EM, DI, TC, ECM,
28	C9	303@2000	166	112.0	999@1200	228	92.0	EM, DI, TC, ECM,
29	C9	264@1800	163	99.0	991@1300	204	89.0	EM, DI, TC, ECM,
32	C9	213@1850	130	81	909@1300	181	79	EM, DI, TC, ECM,
33	C9	213@1850	129	80	909@1300	186	82	EM, DI, TC, ECM
34	C9	250@1800	206	125	1148@1400	232	109	EM, DI, TC, ECM

Engine Model Summary Form

Manufacturer: **CATERPILLAR INC.**

Engine category: **Nonroad Over 50 Hp**

EPA Engine Family: **7CPXL08.8ESK**

Mfr Family Name:

Process Code: **Running Change - 1**

1.Engine Code	2.Engine Model	3.BHP@RPM (SAE Gross)	4.Fuel Rate: mm/stroke @ peak HP (for diesel only)	5.Fuel Rate: (lbs/hr) @ peak HP (for diesels only)	6.Torque @ RPM (SEA Gross)	7.Fuel Rate: mm/stroke@peak torque	8.Fuel Rate: (lbs/hr)@peak torque	9.Emission Control Device Per SAE J1930
39	C9	254@2100	134	95	782@1400	167	79	EM, DI, TC, ECM,
40	C9	373@1500	245	124	1382@1350	252	114	EM, DI, TC, ECM,
41	C9	386@1500	253	127	1410@1350	256	116	EM, DI, TC, ECM,
42	C9	359@2100	194	137	1248@1400	249	117	EM, DI, TC, ECM,
43	C9	217@2000	135	91	782@1200	166	67	EM, DI, TC, ECM,
44	C9	223@2000	137	92	800@1200	169	68	EM, DI, TC, ECM,
45	C9	228@2000	140	94	820@1200	170	69	EM, DI, TC, ECM,
46	C9	233@2000	141	95	850@1200	179	72	EM, DI, TC, ECM,
47	C9	237@2000	147	99	859@1200	180	73	EM, DI, TC, ECM,
48	C9	243@2000	148	100	878@1200	184	74	EM, DI, TC, ECM,
49	C9	248@2000	150	101	898@1200	187	75	EM, DI, TC, ECM,
50	C9	253@2000	152	102	917@1200	190	77	EM, DI, TC, ECM,
51	C9	273@2000	155	104	994@1200	203	82	EM, DI, TC, ECM,

Engine Model Summary Form

Manufacturer: **CATERPILLAR INC.**

Engine category: **Nonroad Over 50 Hp**

EPA Engine Family: **7CPXL08.8ESK**

Mfr Family Name:

Process Code: **Running Change - 2**

1.Engine Code	2.Engine Model	3.BHP@RPM (SAE Gross)	4.Fuel Rate: mm/stroke @ peak HP (for diesel only)	5.Fuel Rate: (lbs/hr) @ peak HP (for diesels only)	6.Torque @ RPM (SEA Gross)	7.Fuel Rate: mm/stroke@peak torque	8.Fuel Rate: (lbs/hr)@peak torque	9.Emission Control Device Per SAE J1930
14			176	130		229	108	
40					NA	NA	NA	
41					NA	NA	NA	
52	C9	286@2000	153	103	885@1400	184	87	EM, DI, TC, ECM,
53	C9	275@1800	159	97	904@1400	185	87	EM, DI, TC, ECM,
54	C9	300@1800	172	104	988@1400	197	93	EM, DI, TC, ECM,

Engine Model Summary Form

Manufacturer: **CATERPILLAR INC.**

Engine category: **Nonroad Over 50 Hp**

EPA Engine Family: **7CPXL08.8ESK**

Mfr Family Name:

Process Code: **Running Change - 3**

1.Engine Code	2.Engine Model	3.BHP@RPM (SAE Gross)	4.Fuel Rate: mm/stroke @ peak HP (for diesel only)	5.Fuel Rate: (lbs/hr) @ peak HP (for diesels only)	6.Torque @ RPM (SEA Gross)	7.Fuel Rate: mm/stroke@peak torque	8.Fuel Rate: (lbs/hr)@peak torque	9.Emission Control Device Per SAE J1930
55	C9	228@1850	139	86	980@1300	199	87	EM, DI, TC, ECM,
56	C9	228@1850	142	88	980@1300	195	85	EM, DI, TC, ECM,
57	C9	213@1850	132	82	909@1300	183	80	EM, DI, TC, ECM,
58	C9	213@1850	132	82	909@1300	183	80	EM, DI, TC, ECM,
59	C9	228@1850	138	86	980@1300	197	86	EM, DI, TC, ECM,

Engine Model Summary Form

Manufacturer: **CATERPILLAR INC.**

Engine category: **Nonroad Over 50 Hp**

EPA Engine Family: **7CPXL08.8ESK**

Mfr Family Name:

Process Code: **Running Change - 4**

1.Engine Code	2.Engine Model	3.BHP@RPM (SAE Gross)	4.Fuel Rate: mm/stroke @ peak HP (for diesel only)	5.Fuel Rate: (lbs/hr) @ peak HP (for diesels only)	6.Torque @ RPM (SEA Gross)	7.Fuel Rate: mm/stroke@peak torque	8.Fuel Rate: (lbs/hr)@peak torque	9.Emission Control Device Per SAE J1930
60	C9	350@1800	202	122	1148@1400	229	108	EM, DI, TC, ECM,

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

2007 Model Year Certificate of Conformity

Manufacturer:	**CATERPILLAR INC.**
Engine Family:	**7CPXL08.8ESK**
Certificate Number:	**CPX-NRCI-07-02**
Intended Service Class:	**NR 7 (225-450 KW)**
Fuel Type:	**DIESEL**
FELs: g/kW-hr	NMHC+NOx: **N/A** NOx: **N/A** PM: **N/A**
Effective Date:	**9/8/2006**
Date Issued:	SEP 08 2006

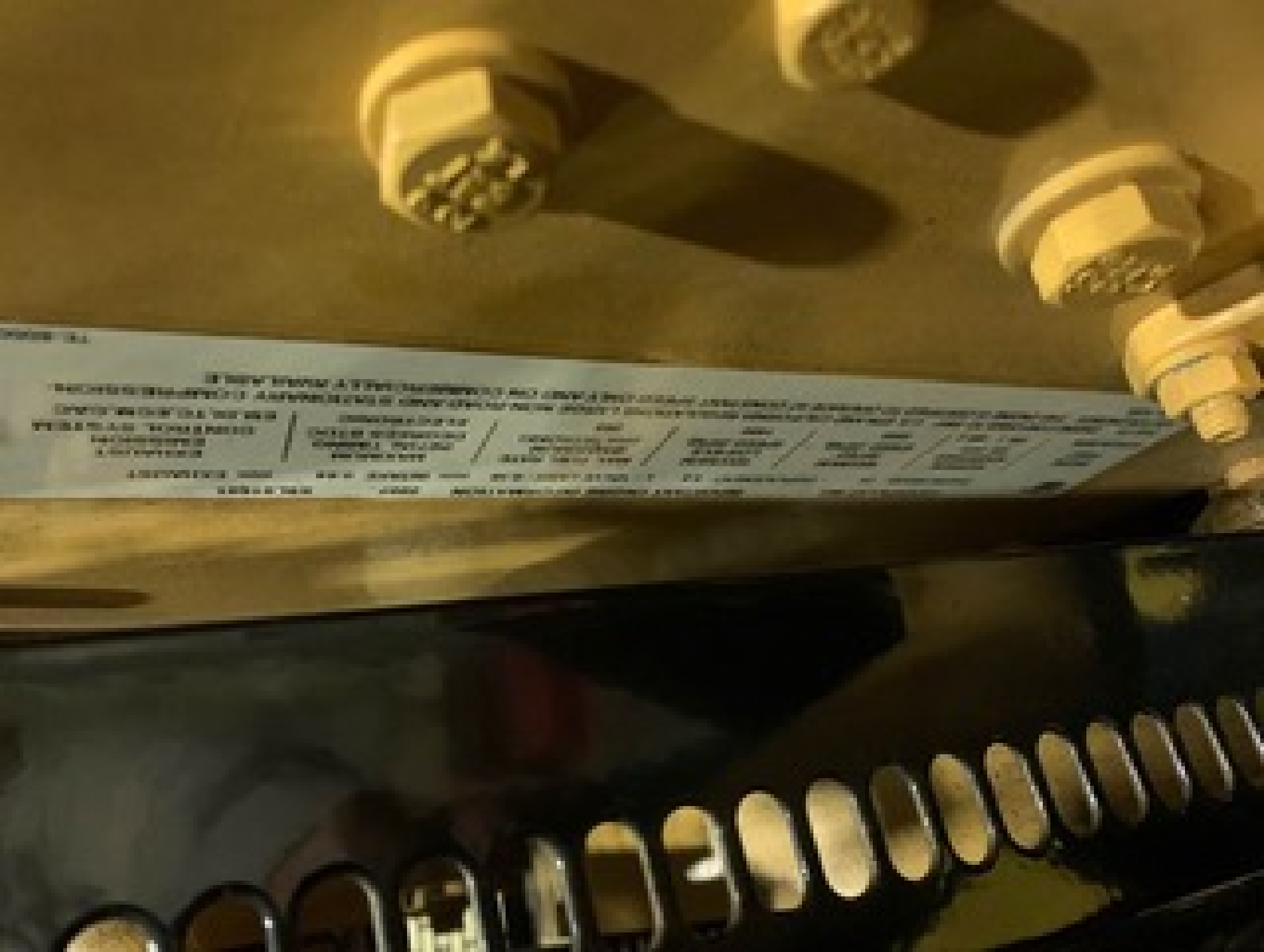
Karl J. Simon, Acting Director
Compliance and Innovative Strategies Division
Office of Transportation and Air Quality

Pursuant to Section 213 of the Clean Air Act (42 U.S.C. section 7547) and 40 CFR Part 89, and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued with respect to the test engines which have been found to conform to applicable requirements and which represent the following nonroad engines, by engine family, more fully described in the documentation required by 40 CFR Part 89 and produced in the stated model year.

This certificate of conformity covers only those new nonroad compression-ignition engines which conform in all material respects to the design specifications that applied to those engines described in the documentation required by 40 CFR Part 89 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 89.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 89.129-96 and 89.506-96 and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 89. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void ab initio for other reasons specified in 40 CFR Part 89.

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




CATERPILLAR
STATIONARY ENGINE GENERATOR ASSEMBLY
Engine Model C9
Year 2008
375 kVA 300 kW 0.8 60 Hertz
Prime X Standby Continuous
Generator Data
Generator Data Description
3 Phase 12 Wire
X Wye Delta
Series X Parallel
Generator 208 Volts 1040 Amps
Sub-Transient X"D 0.1231 Per Unit 0.0142 Ohms
Transient X'D 0.1760 Per Unit 0.0203 Ohms
Excitation 39 Volts 3.9 Amps
60Hz Frame 1600 Rev/Min
Maximum Temperature Rise 105 °C By Resistance
40 °C Ambient 1000 Meters Altitude
Class H Insulation
Enclosure Type:

ISO Partial Load Performance

Performance at partial load and ISO ambient conditions for the Capstone Model C30 MicroTurbine operating on high pressure natural gas fuel is presented in Table 7. These values are estimated from nominal performance curves.

Table 7. Partial Load Performance at ISO Ambient Conditions

Net Power (kW)	Net Efficiency (%)	Exhaust Temp (F)	Exhaust Mass Flow Rate (lbm/s)	Exhaust Energy (Btu/hr)	Fuel Flow Energy (Btu/hr LHV)	Heat Rate (Btu/kWhr LHV)
2.0	8.8	395	0.24	74700	77900	38900
3.0	11.5	386	0.27	81900	89000	29700
4.0	13.6	392	0.29	90200	100000	25100
5.0	15.2	398	0.31	98700	112000	22400
6.0	16.6	405	0.33	107000	123000	20600
7.0	17.7	411	0.35	115000	135000	19200
8.0	18.8	416	0.37	123000	145000	18200
9.0	19.8	421	0.38	130000	155000	17300
10.0	20.6	426	0.40	138000	166000	16600
11.0	21.2	432	0.41	145000	177000	16100
12.0	21.8	438	0.43	153000	188000	15600
13.0	22.3	443	0.44	161000	199000	15300
14.0	22.8	448	0.46	169000	209000	15000
15.0	23.2	454	0.47	177000	220000	14700
16.0	23.6	459	0.49	185000	231000	14400
17.0	24.0	464	0.50	193000	242000	14200
18.0	24.3	468	0.52	201000	253000	14000
19.0	24.6	473	0.53	209000	263000	13900
20.0	24.9	478	0.54	217000	274000	13700
21.0	25.1	483	0.56	226000	286000	13600
22.0	25.3	488	0.57	234000	297000	13500
23.0	25.4	493	0.58	243000	308000	13400
24.0	25.6	498	0.60	252000	320000	13300
25.0	25.7	503	0.61	261000	332000	13300
26.0	25.8	509	0.63	271000	344000	13200
27.0	25.8	514	0.64	281000	357000	13200
28.0	25.9	518	0.65	290000	368000	13200
29.0	26.0	523	0.67	299000	381000	13100
30.0	26.0	529	0.68	310000	394000	13100

Capstone Turbine Corporation • 21211 Nordhoff Street • Chatsworth • CA 91311 • USA
Phone: (818) 734-5300 • Fax: (818) 734-5320 • Web: www.microturbine.com

Technical Reference

Capstone MicroTurbine™ Systems Emissions

Summary

Capstone MicroTurbine™ systems are inherently clean and can meet some of the strictest emissions standards in the world. This technical reference is to provide customers with information that may be requested by local air permitting organizations or to compare air quality impacts of different technologies for a specific project. The preferred units of measure are "output based"; meaning that the quantity of a particular exhaust emission is reported relative to the useable output of the microturbine – typically in pounds per megawatt hour for electrical generating equipment. This technical reference also provides volumetric measurements in parts per million and milligrams per normal cubic meter. A conversion between several common units is also provided.

Maximum Exhaust Emissions at ISO Conditions

Table 1 below summarizes the exhaust emissions at full power and ISO conditions for different Capstone microturbine models. Note that the fuel can have a significant impact on certain emissions. For example landfill and digester gas can be made up of a wide variety of fuel elements and impurities, and typically contains some percentage of carbon dioxide (CO_2). This CO_2 dilutes the fuel, makes complete combustion more difficult, and results in higher carbon monoxide emissions (CO) than for pipeline-quality natural gas.

Table 1. Emission for Different Capstone Microturbine Models in [lb/MWhe]

Model	Fuel	NOx	CO	VOC (5)
C30 NG	Natural Gas (1)	0.64	1.8	0.23
CR30 MBTU	Landfill Gas (2)	0.64	22.0	1.00
CR30 MBTU	Digester Gas (3)	0.64	11.0	1.00
C30 Liquid	Diesel #2 (4)	2.60	0.41	0.23
C65 NG Standard	Natural Gas (1)	0.46	1.25	0.10
C65 NG Low NOx	Natural Gas (1)	0.17	1.30	0.10
C65 NG CARB	Natural Gas (1)	0.17	0.24	0.05
CR65 Landfill	Landfill Gas (2)	0.46	4.0	0.10
CR65 Digester	Digester Gas (3)	0.46	4.0	0.10
C200 NG	Natural Gas (1)	0.40	1.10	0.10
C200 NG CARB	Natural Gas (1)	0.14	0.20	0.04
CR200 Digester	Digester Gas (3)	0.40	3.6	0.10

Notes:

(1) Emissions for standard natural gas at 1,000 BTU/scf (HHV) or 39.4 MJ/m3 (HHV)
(2) Emissions for surrogate gas containing 42% natural gas, 39% CO2, and 19% Nitrogen
(3) Emissions for surrogate gas containing 63% natural gas and 37% CO2
(4) Emissions for Diesel #2 according to ASTM D975-07b
(5) Expressed as Methane

Table 2 provides the same output-based information shown in Table 1, but expressed in grams per horsepower hour (g/hp-hr).

Table 2. Emission for Different Capstone Microturbine Models in [g/hp-hr]

Model	Fuel	NOx	CO	VOC [5]
C30 NG	Natural Gas [1]	0.22	0.60	0.078
CR30 MBTU	Landfill Gas [2]	0.22	7.4	0.340
CR30 MBTU	Digester Gas [3]	0.22	3.7	0.340
C30 Liquid	Diesel #2 [4]	0.90	0.14	0.078
C65 NG Standard	Natural Gas [1]	0.16	0.42	0.034
C65 NG Low NOx	Natural Gas [1]	0.06	0.44	0.034
C65 NG CARB	Natural Gas [1]	0.06	0.08	0.017
CR65 Landfill	Landfill Gas [2]	0.16	1.4	0.034
CR65 Digester	Digester Gas [3]	0.16	1.4	0.034
C200 NG	Natural Gas [1]	0.14	0.37	0.034
C200 NG CARB	Natural Gas [1]	0.05	0.07	0.014
CR200 Digester	Digester Gas [3]	0.14	1.3	0.034

Notes: - same as for Table 1

Emissions may also be reported on a volumetric basis, with the most common unit of measurement being parts per million. This is typically a measurement that is corrected to specific oxygen content in the exhaust and without considering moisture content. The abbreviation for this unit of measurement is “ppmvd” (parts per million by volume, dry) and is corrected to 15% oxygen for electrical generating equipment such as microturbines. The relationship between an output based measurement like pounds per MWh and a volumetric measurement like ppmvd depends on the characteristics of the generating equipment and the molecular weight of the criteria pollutant being measured. Table 3 expresses the emissions in ppmvd at 15% oxygen for the Capstone microturbine models shown in Table 1. Note that raw measurements expressed in ppmv will typically be lower than the corrected values shown in Table 3 because the microturbine exhaust has greater than 15% oxygen.

Another volumetric unit of measurement expresses the mass of a specific criteria pollutant per standard unit of volume. Table 4 expresses the emissions in milligrams per normal cubic meter at 15% oxygen. Normal conditions for this purpose are expresses as one atmosphere of pressure and zero degrees Celsius. Note that both the ppmvd and mg/m3 measurements are for specific oxygen content. A conversion can be made to adjust either unit of measurement to other reference oxygen contents, if required. Use the equation below to convert from one reference oxygen content to another:

$$\text{Emissions at New } O_2 = \frac{(20.9 - \text{New } O_2 \text{ Percent})}{(20.9 - \text{Current } O_2 \text{ Percent})} \text{ X Emissions at Current } O_2$$

For example, to express 9 ppmvd of NOx at 15% oxygen to ppmvd at 3% oxygen:

$$\text{Emissions at 3\% } O_2 = \frac{(20.9 - 3.0)}{(20.9 - 15.0)} \text{ X } 9 = 27 \text{ ppmvd}$$

Table 3. Emission for Different Capstone Microturbine Models in [ppmvd] at 15% O_2

Model	Fuel	NOx	CO	VOC
C30 NG	Natural Gas (1)	9	40	9
CR30 MBTU	Landfill Gas (2)	9	500	40
CR30 MBTU	Digester Gas (3)	9	250	40
C30 Liquid	Diesel #2 (4)	35	9	9
C65 NG Standard	Natural Gas (1)	9	40	7
C65 NG Low NOx	Natural Gas (1)	4	40	7
C65 NG CARB	Natural Gas (1)	4	8	3
CR65 Landfill	Landfill Gas (2)	9	130	7
CR65 Digester	Digester Gas (3)	9	130	7
C200 NG	Natural Gas (1)	9	40	7
C200 NG CARB	Natural Gas (1)	4	8	3
CR200 Digester	Digester Gas (3)	9	130	7

Notes: same as Table 1

Table 4. Emission for Different Capstone Microturbine Models in [mg/m3] at 15% O_2

Model	Fuel	NOx	CO	VOC (5)
C30 NG	Natural Gas (1)	18	50	6
CR30 MBTU	Landfill Gas (2)	18	620	30
CR30 MBTU	Digester Gas (3)	18	310	30
C30 Liquid	Diesel #2 (4)	72	11	6
C65 NG Standard	Natural Gas (1)	19	50	5
C65 NG Low NOx	Natural Gas (1)	8	50	5
C65 NG CARB	Natural Gas (1)	8	9	2
CR65 Landfill	Landfill Gas (2)	18	160	5
CR65 Digester	Digester Gas (3)	18	160	5
C200 NG	Natural Gas (1)	18	50	5
C200 NG CARB	Natural Gas (1)	8	9	2
CR200 Digester	Digester Gas (3)	18	160	5

Notes: same as Table 1

The emissions stated in Tables 1, 2, 3 and 4 are guaranteed by Capstone for new microturbines during the standard warranty period. They are also the expected emissions for a properly maintained microturbine according to manufacturer's published maintenance schedule for the useful life of the equipment.

Emissions at Full Power but Not at ISO Conditions

The maximum emissions in Tables 1, 2, 3 and 4 are at full power under ISO conditions. These levels are also the expected values at full power operation over the published allowable ambient temperature and elevation ranges.

Emissions at Part Power

Capstone microturbines are designed to maintain combustion stability and low emissions over a wide operating range. Capstone microturbines utilize multiple fuel injectors, which are switched on or off depending on the power output of the turbine. All injectors are typically on when maximum power is demanded, regardless of the ambient temperature or elevation. As the load requirements of the microturbine are decreased, injectors will be switched off to maintain stability and low emissions. However, the emissions relative to the lower power output may increase. This effect differs for each microturbine model.

Emissions Calculations for Permitting

Air Permitting agencies are normally concerned with the maximum amount of a given pollutant being emitted per unit of time (for example pounds per day of NOx). The simplest way to make this calculation is to use the maximum microturbine full electrical power output (expressed in MW) multiplied by the emissions rate in pounds per MWhe times the number of hours per day. For example, the C65 CARB microturbine operating on natural gas would have a NOx emissions rate of:

NOx = .17 X (65/1000) X 24 = .27 pounds per day

This would be representative of operating the equipment full time, 24 hours per day, at full power output of 65 kWe.

As a general rule, if local permitting is required, use the published agency levels as the stated emissions for the permit and make sure that this permitted level is above the calculated values in this technical reference.

Consideration of Useful Thermal Output

Capstone microturbines are often deployed where their clean exhaust can be used to provide heating or cooling, either directly or using hot water or other heat transfer fluids. In this case, the local permitting or standards agencies will usually consider the emissions from traditional heating sources as being displaced by the useful thermal output of the microturbine exhaust energy. This increases the useful output of the microturbine, and decreases the relative emissions of the combined heat and power system. For example, the CARB version C65 ICHP system with integral heat recovery can achieve a total system efficiency of 70% or more, depending on inlet water temperatures and other installation-specific characteristics. The electric efficiency of the CARB version C65 microturbine is 28% at ISO conditions. This means that the total NOx output based emissions, including the captured thermal value, is the electric-only emissions times the ratio of electric efficiency divided by total system efficiency:

NOx = .17 X 28/70 = .068 pounds per MWh (based on total system output)

This is typically much less than the emissions that would result from providing electric power using traditional central power plants, plus the emissions from a local hot water heater or boiler. In fact microturbine emissions are so low compared with traditional hot water heaters that installing a Capstone microturbine with heat recovery can actually decrease the local emissions of NOx and other criteria pollutants, without even considering the elimination of emissions from a remote power plant.

Greenhouse Gas Emissions

Many gasses are considered "greenhouse gasses", and agencies have ranked them based on their global warming potential (GWP) in the atmosphere compared with carbon dioxide (CO_2), as well as their ability to maintain this effect over time. For example, methane is a greenhouse gas with a GWP of 21. Criteria pollutants like NOx and organic compounds like methane are monitored by local air permitting authorities, and are subject to strong emissions controls. Even though some of these criteria pollutants can be more troublesome for global warming than CO_2, they are released in small quantities – especially from Capstone microturbines. So the major contributor of concern is carbon dioxide, or CO_2. Emission of CO_2 depends on two things:

1. Carbon content in the fuel
2. Efficiency of converting fuel to useful energy

It is for these reasons that many local authorities are focused on using clean fuels (for example natural gas compared with diesel fuel), achieving high efficiency using combined heat and power systems, and displacing emissions from traditional power plants using renewable fuels like waste landfill and digester gasses.

Table 5 shows the typical CO_2 emissions due to combustion for different Capstone microturbine models at full power and ISO conditions. The values do not include CO_2 that may already exist in the fuel itself, which is typical for renewable fuels like landfill and digester gas. These values are expressed on an output basis, as is done for criteria pollutants in Table 1. The table shows the pounds per megawatt hour based on electric power output only, as well as considering total useful output in a CHP system with total 70% efficiency (LHV). As for criteria pollutants, the relative quantity of CO_2 released is substantially less when useful thermal output is also considered in the measurement.

Table 5. CO_2 Emission for Capstone Microturbine Models in [lb/MWh]

Model	Fuel	CO_2	
		Electric Only	70% Total CHP
C30 NG	Natural Gas (1)	1,690	625
CR30 MBTU	Landfill Gas (1)	1,690	625
CR30 MBTU	Digester Gas (1)	1,690	625
C30 Liquid	Diesel #2 (2)	2,400	855
C65 NG Standard	Natural Gas (1)	1,520	625
C65 NG Low NOx	Natural Gas (1)	1,570	625
C65 NG CARB	Natural Gas (1)	1,570	625
CR65 Landfill	Landfill Gas (1)	1,520	625
CR65 Digester	Digester Gas (1)	1,520	625
C200 NG	Natural Gas (1)	1,330	625
C200 NG CARB	Natural Gas (1)	1,330	625
CR200 Digester	Digester Gas (1)	1,330	625

Notes:

(1) Emissions due to combustion, assuming natural gas with CO_2 content of 117 lb/MMBTU (HHV)

(2) Emissions due to combustion, assuming diesel fuel with CO_2 content of 160 lb/MMBTU (HHV)

Useful Conversions

The conversions shown in Table 6 can be used to obtain other units of emissions outputs. These are approximate conversions.

Table 6. Useful Unit Conversions

From	Multiply By	To Get
lb/MWh	0.338	g/bhp-hr
g/bhp-hr	2.96	lb/MWh
lb	0.454	kg
kg	2.20	lb
kg	1,000	g
hp (electric)	.746	kW
kW	1.34	hp (electric)
MW	1,000	kW
kW	0.001	MW

Definitions

- ISO conditions are defined as: 15 °C (59 °F), 60% relative humidity, and sea level pressure of 101.3 kPa (14.696 psia).
- HHV: Higher Heating Value
- LHV: Lower Heating Value
- kW_{th}: Kilowatt (thermal)
- kW_e : Kilowatt (electric)
- MWh: Megawatt-hour
- hp-hr: horsepower-hour (sometimes referred to as “electric horsepower-hour”)
- Scf: Standard cubic foot (standard references ISO temperature and pressure)
- m3: Normal cubic meter (normal references 0 °C and one atmosphere pressure)

Capstone Contact Information

If questions arise regarding this technical reference, please contact Capstone Turbine Corporation for assistance and information:

Capstone Applications

Toll Free Telephone: (866) 4-CAPSTONE or (866) 422-7786

Fax: (818) 734-5385

E-mail: applications@capstoneturbine.com