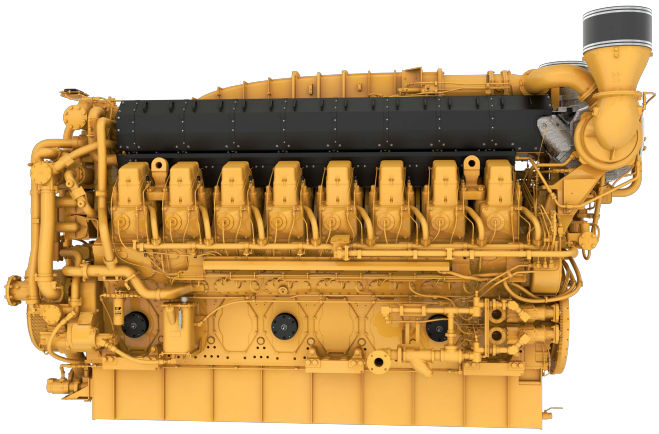
G3616 with ADEM™ A4 Gas Engine

3729-3990 bkW (5000-5350 bhp) @ 1000 rpm
0.5 g/bhp-hr NOx (NTE)



Shown with optional equipment

Cat® Engine Specifications

V-16, 4-Stroke-Cycle

Bore
300 mm (11.8 in)

Stroke
300 mm (11.8 in)

Displacement
339 L (20,698 cu. in)

Aspiration
Turbocharged-Aftercooled

Digital Engine Management Governor and Protection
Electronic (ADEM™ A4)

Combustion
Low Emission (Lean Burn)

Cooling System Capacity
Total..... 798 L (211 Gal)
JW..... 690 L (182 Gal)
SCAC.....108 L (29 Gal)

Lube Oil System (refill)
1329 L (351 gal)

Oil Change Interval
5000 hours

Rotation (from flywheel end)
Counterclockwise

Flywheel Teeth
255

FEATURES AND BENEFITS

Engine Design

- Industry-leading power with ambient-based rating capability
- ADEM A4 engine control system provides complete engine control, monitoring, and protection while maintaining emissions.
- Widest fuel tolerance in the industry for application flexibility
- Proven reliability and durability with the lowest owning and operating costs
- Factory-installed thermostats

Emissions
Meets U.S. EPA Spark Ignited Stationary NSPS Emissions for 2010 with the use of an oxidation catalyst

Lean Burn Engine Technology
Lean-burn engines operate with large amounts of excess air. The excess air absorbs heat during combustion reducing the combustion temperature and pressure, greatly reducing levels of NOx. Lean-burn design also provides longer component life and excellent fuel consumption.

Ease of Operation
Side covers on block allow for inspection of internal components

Advanced Digital Engine Management
ADEM A4 engine management system integrates speed control, air/fuel ratio control, and ignition/detonation controls into a complete engine management system. ADEM A4 has improved: user interface, display system, shutdown controls, and system diagnostics.

Full Range of Attachments
Large variety of factory-installed attachments reduces packaging time.

Testing
Every engine is full-load tested to ensure proper engine performance.

Gas Engine Rating Pro (GERP)
GERP is a PC-based program designed to provide site performance capabilities for Cat natural gas engines for the gas compression industry. GERP provides engine data for your site's altitude, ambient temperature, fuel, engine coolant heat rejection, performance data, installation drawings, spec sheets, and pump curves.

Product Support Offered Through Global Cat Dealer Network

- More than 2,200 dealer outlets
- Cat factory-trained dealer technicians service every aspect of your Oil & Gas Engine
- Caterpillar parts and labor warranty
- Preventive maintenance agreements available for repair-before-failure options
- S•O•S℠ program matches your oil and coolant samples against Caterpillar set standards to determine:
  - Internal engine component condition
  - Presence of unwanted fluids
  - Presence of combustion by-products
  - Site-specific oil change interval

Over 80 Years of Engine Manufacturing Experience
Over 60 years of natural gas engine production. Ownership of these manufacturing processes enables Caterpillar to produce high quality, dependable products.

- Cast engine blocks, heads, cylinder liners, and flywheel housings
- Machine critical components
- Assemble complete engine

Web Site
For all your Oil & Gas power requirements, visit www.cat.com

LET'S DO THE WORK.™

CAT®

STANDARD EQUIPMENT

G3616 with ADEM A4 Gas Engine

Air Inlet System
- Air cleaner — standard duty
- Inlet air adapter

Control System
- ADEM A4 control system — provides electronic governing integrated with air/fuel ratio control
- Electrical system and instrumentation certified for Class I, Division 2, Group D hazardous location.

Cooling System
- Compressor oil cooler connections
- Jacket water pump
- Jacket water thermostats and housing
- Aftercooler/oil cooler pump
- Aftercooler/oil cooler thermostats and housing
- Two-stage aftercooler
- Jacket water heater connections
- Standard ANSI connections

Exhaust System
- Dry exhaust manifolds
- Single vertical outlet adapter
- Dual layer hard heat shield

Flywheels & Flywheel Housings
- SAE standard rotation

Fuel System
- Gas admission valves — electronically controlled fuel supply pressure

Ignition System
- ADEM A4 control system — senses individual cylinder detonation and controls individual cylinder timing

Lube System
- Crankcase breather —top mounted
- Oil cooler
- Oil filter
- Oil pan drain valve - front and rear

Mounting System
- Engine mounting feet (six total)

Protection System
- Electronic shutoff system with purge cycle
- Crankcase explosion relief valves
- Gas shutoff valve

Starting System
- Air starting system

General
- Paint, Caterpillar yellow
- Single vibration damper with guard

OPTIONAL EQUIPMENT

Air Inlet System
- Heavy-duty air cleaner with precleaners

Charging System
- 35 Amp & 65 Amp charging alternators - CSA Approved

Exhaust System
- Flexible bellows adapters
- Exhaust expander
- Weld flanges

Fuel System
- Fuel filter
- Gas pressure regulator
- Flexible connection

Instrumentation
- Color 8" HMI touchscreen panel
- Remote data monitoring and speed control
- Compatible with Cat Electronic Technician (ET) and Data View
- Modbus and Ethernet capable

Lube System
- Air or electric motor-driven prelube
- Duplex oil filter
- RH service
- Lube oil makeup system

Mounting System
- Mounting plates (set of six)
- Extra mounting feet (set of two)
- Extra mounting plates (set of two)

Power Take-offs
- Front stub shafts

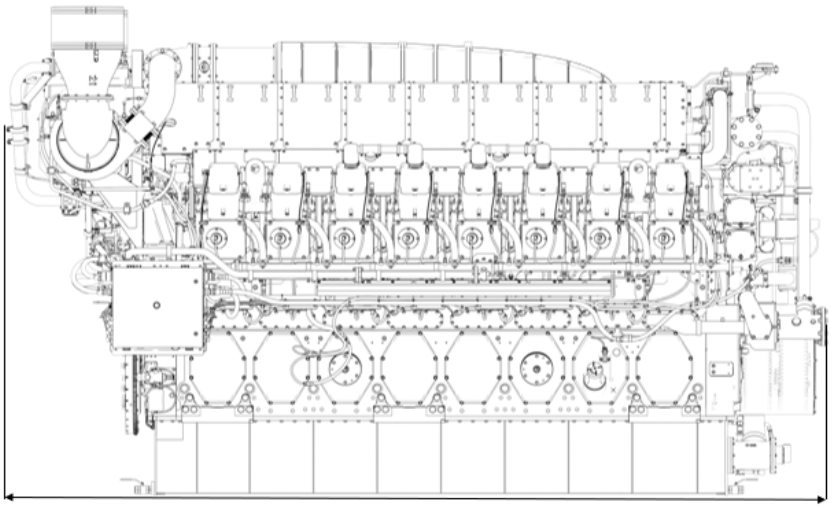
Starting System
- Air pressure reducing valve

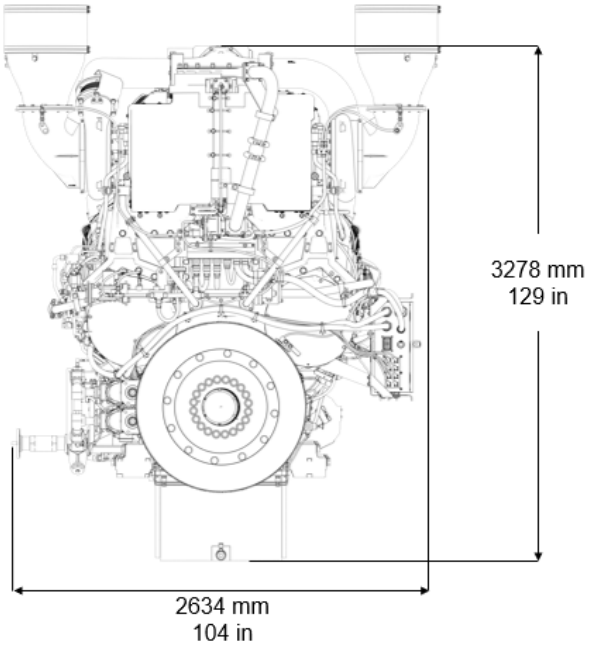
General
- Engine barring device
- Dual vibration damper with guard

Performance Number		EM0455-08	EM0456-08	EM0457-08
Rating	°C (°F)	54 (130)	43 (110)	32 (90)
Engine Power	bkW (bhp)	3729 (5000)	3859 (5175)	3990 (5350)
Engine Speed	rpm	1000	1000	1000
Max Altitude @ Rated Torque and 38°C (100°F)	m (ft)	1781 (5849)	1652.5 (5427)	1524 (5005)
Speed Turndown @ Max Altitude, Rated Torque, and 38°C (100°F)	%	25	25	25
Aftercooler Temperature				
Stage 1 (JW)	°C (°F)	88 (190)	88 (190)	88 (190)
Stage 2 (SCAC)	°C (°F)	54 (130)	43 (110)	32 (90)
Emissions (NTE)*				
NOx	g/bkW-hr (g/bhp-hr)	0.67 (0.5)	0.67 (0.5)	0.67 (0.5)
CO	g/bkW-hr (g/bhp-hr)	2.95 (2.2)	2.95 (2.2)	2.95 (2.2)
CO_2	g/bkW-hr (g/bhp-hr)	565 (421)	564 (420)	563 (420)
VOC**	g/bkW-hr (g/bhp-hr)	0.33 (0.25)	0.32 (0.24)	0.31 (0.23)
Fuel Consumption ***	MJ/bkW-hr (Btu/bhp-hr)	9.23 (6527)	9.2 (6507)	9.18 (6488)
Heat Balance				
Heat Rejection to Jacket Water	bkW (Btu/min)	928 (52789)	933 (53051)	936 (53244)
Heat Rejection to Oil Cooler	bkW (Btu/min)	539 (30644)	556 (31622)	573 (32593)
Heat Rejection to Aftercooler				
Stage 1 (JW)	bkW (Btu/min)	688 (39099)	729 (41482)	773 (43937)
Stage 2 (SCAC)	bkW (Btu/min)	196 (11141)	267 (15174)	341 (19397)
Heat Rejection to Exhaust LHV To 25°C (77°F)	bkW (Btu/min)	3338 (189801)	3380 (192221)	3420 (194499)
Heat Rejection to Atmosphere	bkW (Btu/min)	329 (18702)	334 (18979)	336 (19100)
Exhaust System				
Exhaust Gas Flow Rate	m^3/min (scfm)	869.72 (30714)	886.23 (31297)	902.42 (31869)
Exhaust Stack Temperature	°C (°F)	449 (840)	444 (831)	438 (821)
Intake System				
Air Inlet Flow Rate	m^3/min (scfm)	335.86 (11861)	344.7 (12173)	353.53 (12485)
Gas Pressure	kPag (psig)	400 - 485 (58 - 70)	400 - 485 (58 - 70)	400 - 485 (58 - 70)

All technical data is based on 100% load and speed
* listed as not to exceed
** Volatile organic compounds as defined in U.S. EPA 40 CFR 60, subpart JJJJ
*** ISO 3046/1

TECHNICAL DATA G3616 with ADEM A4 Gas Engine





Note: General configuration not to be used for installation

Dimensions		
Length	6125.6 mm	241.17 in
Width	2634 mm	104 in
Height	3278 mm	129 in
Weight	32,659 kg	72,000 lb

Rating Definitions and Conditions

Engine performance is obtained in accordance with SAE J1995, ISO3046/1, BS5514/1, and DIN6271/1 standards.

Conditions: Power for gas engines is based on fuel having an LHV of 33.74 kJ/L (905 Btu/cu ft) at 101 kPa (29.91 in Hg) and 15°C (59°F). Fuel rate is based on a cubic meter at 100 kPa (29.61 in Hg) and 15.6°C (60.1°F). Air flow is based on a cubic foot at 100 kPa (29.61 in Hg) and 25°C (77°F). Exhaust flow is based on a cubic foot at 100 kPa (29.61 in Hg) and stack temperature.

To find your nearest dealer, please visit: www.cat.com

Subject to change without notice.
LEHW0198-03

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LET'S DO THE WORK.™

CAT®

ICE CATALYST SIZING PROGRAM

rev 2.1.3

Report Date: 10/29/2026

Customer	OneOK	Housing Element	APXP-OX-SQ-1550-2475-350
Sales Person	MG	Contact	Lance Green
Project	Red Raider/Reveille		
Engine Name	Caterpillar G3612 A4		

Engine Power	3750.0	BHP	ACFM	23872.0	CU. FT/MIN	Exhaust O2	7.7	%
Exhaust Mass Flow	42986.0	LBS/HR	ACFH	1432320	CU. FT/HR	Exhaust CO2	6.4	%
Process Temperature	820.0	F	SCFM	9713.3	CU. FT/MIN	Exhaust H2O	11.6	%
Exhaust Pressure	14.5	PSI	SCFH	582800	CU. FT/HR	Exhaust N2	74.3	%
Exhaust Density	0.0300	LBS/FT^3	Std Temp	68.0	F	Max Pressure Drop	12.0	in wc
Molecular Weight	28.43	AMU	Std Pressure	14.6959	PSI	Propane in Fuel	5.57	%

ACS Part Name	R14.875X23.875X3.500-400				
OEM Part Name	ERZ-1524-3-400				
Type	Propane Oxidation	Layers	1		
Geometry	Rectangular	Modules/Layer	6	Cell Count	400cpsi
X	14.875in	Guard Bed	No	Depth	3.500in
Y	23.875in				

Open Area	13.225	ft^2	Part Volume	0.643	ft^3	Part Weight	47	lbs
Linear Velocity	1805	ft/min	Total Volume	3.857	ft^3	Total Weight	284	lbs
Pressure Drop	3.2	in wc	Space Velocity	151095	GHSV			

Inlet Emissions

	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.300	2.48	10.87	35.64	40.32	19.52
CO	3.050	25.22	110.52	595.20	673.30	325.89
VOC	1.130	9.34	40.95	140.06	158.44	76.69
H2CO	0.190	1.57	6.88	34.58	39.12	18.94

Target Emissions

	min %DRE	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.00	0.300	2.48	10.87	35.64	40.32	19.52
CO	86.89	0.400	3.31	14.49	78.06	88.30	42.74
VOC	55.75	0.500	4.13	18.12	61.97	70.11	33.93
H2CO	87.89	0.023	0.19	0.83	4.19	4.74	2.29

Emissions with Catalyst

	%DRE	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.00	≤0.300	≤2.48	≤10.87	≤35.64	≤40.32	≤19.52
CO	86.89	≤0.400	≤3.31	≤14.49	≤78.06	≤88.30	≤42.74
VOC	55.75	≤0.500	≤4.13	≤18.12	≤61.97	≤70.11	≤33.93
H2CO	87.89	≤0.023	≤0.19	≤0.83	≤4.19	≤4.74	≤2.29

Safety Value: 2 VOC Molecular Weight: 44.1 O2 Reference Value: 15 Uptime (TPY): 100% (8760 hours)

ICE CATALYST SIZING PROGRAM

rev 2.1.3

Report Date: 10/29/2026

Customer	OneOk	Housing Element	APXP-OX-SQ-1550-2475-350
Sales Person	MG	Contact	Lance Green
Project	Red Raider/Reveille		
Engine Name	Waukesha 16V275GL		

Engine Power	5000.0	BHP	ACFM	32101.0	CU. FT/MIN	Exhaust O2	6.1	%
Exhaust Mass Flow	55158.0	LBS/HR	ACFH	1926060	CU. FT/HR	Exhaust CO2	6.4	%
Process Temperature	864.0	F	SCFM	12627.5	CU. FT/MIN	Exhaust H2O	11.6	%
Exhaust Pressure	14.5	PSI	SCFH	757650	CU. FT/HR	Exhaust N2	75.9	%
Exhaust Density	0.0286	LBS/FT^3	Std Temp	68.0	F	Max Pressure Drop	12.0	in wc
Molecular Weight	28.06	AMU	Std Pressure	14.6959	PSI	Propane in Fuel	5.57	%

ACS Part Name	RN15.400X24.750X3.500-400				
OEM Part Name	MCCZ-7140-3-400				
Type	Propane Oxidation	Layers	1		
Geometry	Rectangular	Modules/Layer	6	Cell Count	400cpsi
X	15.400in	Guard Bed	No	Depth	3.500in
Y	24.750in				

Open Area	14.250	ft^2	Part Volume	0.693	ft^3	Part Weight	50	lbs
Linear Velocity	2253	ft/min	Total Volume	4.156	ft^3	Total Weight	303	lbs
Pressure Drop	4.0	in wc	Space Velocity	182292	GHSV			

Inlet Emissions

	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.300	3.31	14.49	36.56	41.35	17.43
CO	2.380	26.24	114.99	476.35	538.86	227.10
VOC	1.020	11.24	49.28	129.67	146.68	61.82
H2CO	0.280	3.09	13.53	52.27	59.13	24.92

Target Emissions

	min %DRE	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.00	0.300	3.31	14.49	36.56	41.35	17.43
CO	83.19	0.400	4.41	19.33	80.06	90.57	38.17
VOC	50.98	0.500	5.51	24.16	63.56	71.90	30.30
H2CO	91.79	0.023	0.25	1.11	4.29	4.86	2.05

Emissions with Catalyst

	%DRE	g/bhp-hr	lb/hr	tons/year	ppmv	ppmvd	ppmvd%O2
NOx	0.00	≤0.300	≤3.31	≤14.49	≤36.56	≤41.35	≤17.43
CO	83.19	≤0.400	≤4.41	≤19.33	≤80.06	≤90.57	≤38.17
VOC	50.98	≤0.500	≤5.51	≤24.16	≤63.56	≤71.90	≤30.30
H2CO	91.79	≤0.023	≤0.25	≤1.11	≤4.29	≤4.86	≤2.05

Safety Value: 2 VOC Molecular Weight: 44.1 O2 Reference Value: 15 Uptime (TPY): 100% (8760 hours)

Catalytic Combustion Corporation
311 Riggs Street, Bloomer, WI 54724
Tel: (715) 568-2882 • Fax: (715) 568-2884 • Cell: (817) 899-8177
Email jmartin@catalyticcombustion.com

CATALYTIC COMBUSTION
EMISSION TECHNOLOGIES

To OneOK
Attn Kevin Poffenberger
Via E-mail

Our Ref. 00000804.02
Date: 11 May, 2026

Catalyst Performance

For : CAT G3616

Project/Location : Red Raider & Reveille Station - OneOK

Engine Parameters

Engine Manufacturer	Caterpillar	
Engine Model	G3616	
Horsepower	5500	bhp
Speed	1000	rpm
Exhaust Flowrate	33822	acfm
Exhaust Temperature	790	° F
Fuel	Natural Gas	

	Raw Exhaust	
NOx	0.30	g/bhp-hr
CO	2.15	g/bhp-hr
NMHC	0.24	g/bhp-hr
NMNEHC (VOC)	0.16	g/bhp-hr
HCHO	0.10	g/bhp-hr
Oxygen	11.40	%

Catalyst Description and Performance Expectations

Catalyst Model	GACB-3621F-D-15HF-HFX4	Overall Dimensions	41.5 x 21 x 3.7
Cell Pattern, Substrate	15HF	Catalyst Qty Required	8 per Unit
Formulation	HFX4	Pressure Drop	2.6 inches of H2O
Warranty Period [hrs]	24000		

	Performance	
NOx	0.30	g/bhp-hr
CO	0.40	g/bhp-hr
NMNEHC (VOC)	0.40	g/bhp-hr
HCHO	0.023	g/bhp-hr

Application Notes and Exceptions:

- Engine operating conditions and raw emissions to be confirmed/verified by end user.

Please contact us if you have any questions or to let us know how we can be of further help.

Best regards,

Josh Martin

Josh Martin
Sales and Business Development Manager, Catalytic Combustion Corporation
Prepared By: DW

ENGINE SPEED (rpm):	1000	RATING STRATEGY:	GEN 2 KIT - LOW ALTITUDE - NO CCV
COMPRESSION RATIO:	7.6	APPLICATION:	GAS COMPRESSION
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	CONTINUOUS
AFTERCOOLER - STAGE 2 INLET (°F):	130	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°F):	174	FUEL SYSTEM:	GAV WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	190		
ASPIRATION:	TA	FUEL PRESSURE RANGE(psia): (See note 1)	84.8-94.6
COOLING SYSTEM:	JW+1AC, OC+2AC	FUEL METHANE NUMBER:	85
CONTROL SYSTEM:	ADEM4	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 100°F INLET AIR TEMP. (ft):	3658
COMBUSTION:	LOW EMISSION		
NOx EMISSION LEVEL (g/bhp-hr NOx):	0.3		

RATING		NOTES	LOAD	100%	75%	50%
ENGINE POWER	(WITHOUT FAN)	(2)	bhp	5500	4125	2750
ENGINE EFFICIENCY	(ISO 3046/1)	(3)	%	38.8	37.8	35.6
ENGINE EFFICIENCY	(NOMINAL)	(3)	%	37.9	36.9	34.8
ENGINE DATA						
FUEL CONSUMPTION	(ISO 3046/1)	(4)	Btu/bhp-hr	6554	6734	7145
FUEL CONSUMPTION	(NOMINAL)	(4)	Btu/bhp-hr	6714	6898	7320
AIR FLOW (77°F, 14.7 psia)	(WET)	(5)(6)	ft3/min	13608	10266	6965
AIR FLOW	(WET)	(5)(6)	lb/hr	60341	45519	30883
FUEL FLOW (60°F, 14.7 psia)			scfm	680	524	371
COMPRESSOR OUT PRESSURE			psi(abs)	61.4	45.7	31.3
COMPRESSOR OUT TEMPERATURE			°F	436	356	258
AFTERCOOLER AIR OUT TEMPERATURE			°F	135	135	135
INLET MAN. PRESSURE		(7)	psi(abs)	60.0	44.6	30.5
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(8)	°F	135	135	135
TIMING		(9)	°BTDC	18	17	16
EXHAUST TEMPERATURE - ENGINE OUTLET		(10)	°F	790	844	897
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(6)(11)	ft3/min	33822	26635	18844
EXHAUST GAS MASS FLOW	(WET)	(6)(11)	lb/hr	62205	46956	31900
EMISSIONS DATA - EXHAUST OUT						
NOx (as NO2)		(12)(13)	g/bhp-hr	0.30	0.30	0.30
CO		(12)(14)	g/bhp-hr	2.15	2.15	2.15
NMHC (mol. wt. of 15.84)		(12)(14)	g/bhp-hr	0.24	0.27	0.29
NMNEHC (VOCs) (mol. wt. of 15.84)		(12)(14)(15)	g/bhp-hr	0.16	0.18	0.19
HCHO (Formaldehyde)		(12)(14)	g/bhp-hr	0.10	0.11	0.14
CH4 (mol. wt. of 16.04)	(NOMINAL)	(12)(16)	g/bhp-hr	2.02	2.24	2.40
CO2	(NOMINAL)	(12)(16)	g/bhp-hr	383	400	422
EXHAUST OXYGEN	(NOMINAL)	(12)(17)	% DRY	11.4	11.1	10.7
LAMBDA		(12)(17)		2.04	2.00	1.92
ENERGY BALANCE DATA						
LHV INPUT		(18)	Btu/min	615364	474193	335451
HEAT REJECTION TO JACKET WATER (JW)		(19)(27)	Btu/min	56558	48125	42384
HEAT REJECTION TO ATMOSPHERE		(20)	Btu/min	19751	17841	16213
HEAT REJECTION TO LUBE OIL (OC)		(21)(28)	Btu/min	30768	28452	25159
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(22)(23)	Btu/min	198465	161306	116861
HEAT REJECTION TO EXHAUST (LHV TO 350°F)		(22)	Btu/min	120726	102618	77576
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(24)(27)	Btu/min	58223	30363	9439
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(25)(28)	Btu/min	15421	10235	5828
PUMP POWER		(26)	Btu/min	2957	2957	2957

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77°F, 14.50 PSI barometric pressure.) No overload permitted at rating shown. Consult the altitude deration factor chart for applications that exceed the rated altitude or temperature.

Emission levels are at engine exhaust flange prior to any after treatment. Values are based on engine operating at steady state conditions, adjusted to the specified NOx level at 100% load. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than ± 3.

For notes information consult page three.

FUEL USAGE GUIDE

METHANE NUMBER	<10	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	100
SET POINT TIMING	16	16	16	16	16	16	16	16	16	16	17	17	17	17	18	18	18	18
DERATION FACTOR	0	0.50	0.62	0.75	0.87	1	1	1	1	1	1	1	1	1	1	1	1	1

WOBBE INDEX(BTU/scfm)	700	850	1550	1870
DERATION FACTOR	0.7	1	1	0.82

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1	0.96	0.91	0.87	0.82	0.78	0.73	0.69	0.67	0.66	0.64	0.61	0.59
120	1	1	0.96	0.92	0.87	0.83	0.78	0.74	0.70	0.68	0.65	0.63	0.61
110	1	1	1	0.98	0.93	0.89	0.84	0.80	0.75	0.71	0.68	0.65	0.62
100	1	1	1	1	0.99	0.94	0.89	0.85	0.80	0.76	0.71	0.68	0.65
90	1	1	1	1	1	1	0.95	0.91	0.86	0.81	0.77	0.72	0.68
80	1	1	1	1	1	1	0.98	0.94	0.89	0.84	0.80	0.75	0.70
70	1	1	1	1	1	1	1	0.95	0.90	0.86	0.81	0.76	0.72
60	1	1	1	1	1	1	1	0.96	0.92	0.87	0.83	0.78	0.73
50	1	1	1	1	1	1	1	0.98	0.93	0.89	0.84	0.79	0.75

ALTITUDE (FEET ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.27	1.31	1.35	1.40	1.44	1.48	1.52	1.52	1.52	1.52	1.52	1.52	1.52
120	1.22	1.26	1.30	1.34	1.39	1.43	1.46	1.46	1.46	1.46	1.46	1.46	1.46
110	1.16	1.20	1.24	1.28	1.32	1.37	1.40	1.40	1.40	1.40	1.40	1.40	1.40
100	1.11	1.15	1.19	1.23	1.27	1.31	1.34	1.34	1.34	1.34	1.34	1.34	1.34
90	1.05	1.09	1.13	1.17	1.21	1.25	1.28	1.28	1.28	1.28	1.28	1.28	1.28
80	1	1.04	1.07	1.11	1.15	1.19	1.22	1.22	1.22	1.22	1.22	1.22	1.22
70	1	1	1.02	1.05	1.09	1.13	1.16	1.16	1.16	1.16	1.16	1.16	1.16
60	1	1	1	1	1.03	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.10
50	1	1	1	1	1	1.01	1.04	1.04	1.04	1.04	1.04	1.04	1.04

ALTITUDE (FEET ABOVE SEA LEVEL)

MINIMUM SPEED CAPABILITY AT THE RATED SPEED'S SITE TORQUE (RPM)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	750	750	750	750	750	750	750	750	750	750	750	750	750
120	750	750	750	750	750	750	750	750	750	750	750	750	750
110	750	750	750	750	750	750	750	750	750	750	750	750	750
100	750	750	750	750	750	750	750	750	750	750	750	750	750
90	750	750	750	750	750	750	750	750	750	750	750	750	750
80	750	750	750	750	750	750	750	750	750	750	750	750	750
70	750	750	750	750	750	750	750	750	750	750	750	750	750
60	750	750	750	750	750	750	750	750	750	750	750	750	750
50	750	750	750	750	750	750	750	750	750	750	750	750	750

ALTITUDE (FEET ABOVE SEA LEVEL)

FUEL USAGE GUIDE:

This table shows the derate factor and full load set point timing required for a given fuel. Note that deration and set point timing adjustment may be required as the methane number decreases. Methane number is a scale to measure detonation characteristics of various fuels. The methane number of a fuel is determined by using the Caterpillar methane number calculation.
The Fuel Lower Heating Value (LHV) table shows the derate factor required for a given fuel. To determine the actual power available, use the lowest factor between the Fuel LHV table and the Methane Number table.

ALTITUDE DERATION FACTORS:

This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site. The derate factors shown do not account for the external cooling system capacity. The derate factors provided assume the external cooling system can maintain the specified cooling water temperatures at site conditions.

ACTUAL ENGINE RATING:

To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/ Temperature deration factors and RPC(reference the Caterpillar Methane Program) establish air system limitations. RPC comes into play when the Altitude/Temperature deration is less than 1.0 (100%). Under this condition, add the two factors together. When the site conditions do not require an Altitude/Temperature derate (factor is 1.0), it is assumed the turbocharger has sufficient capability to overcome the low fuel relative power, and RPC is ignored. To determine the actual power available, take the lowest rating between 1) and 2).
1) Fuel Usage Guide Deration
2) 1 - ((1 - Altitude / Temperature Deration) +(1 - RPC))

AFTERCOOLER HEAT REJECTION FACTORS(ACHRF):

To maintain a constant air inlet manifold temperature, as the inlet air temperature goes up, so must the heat rejection. As altitude increases, the turbocharger must work harder to overcome the lower atmospheric pressure. This increases the amount of heat that must be removed from the inlet air by the aftercooler. Use the aftercooler heat rejection factor (ACHRF) to adjust for inlet air temp and altitude conditions. See notes (27) and (28) for application of this factor in calculating the heat exchanger sizing criteria. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

MINIMUM SPEED CAPABILITY AT THE RATED SPEED'S SITE TORQUE (RPM):

This table shows the minimum allowable engine turndown speed where the engine will maintain the Rated Speed's Torque for the given ambient conditions.

NOTES:

1. Fuel pressure range specified is to the engine gas shutoff valve (GSOV). Additional fuel train components should be considered in pressure and flow calculations.
2. Engine rating is with two engine driven water pumps. Tolerance is ± 3% of full load.
3. ISO 3046/1 engine efficiency tolerance is (+)0, (-)5% of full load % efficiency value. Nominal engine efficiency tolerance is ± 2.5% of full load % efficiency value.
4. ISO 3046/1 fuel consumption tolerance is (+)5, (-)0% of full load data. Nominal fuel consumption tolerance is ± 2.5% of full load data.
5. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
6. Inlet and Exhaust Restrictions must not exceed A&I limits based on full load flow rates from the standard technical data sheet.
7. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
8. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
9. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
10. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
11. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
12. Emissions data is at engine exhaust flange prior to any after treatment.
13. NOx values are the maximum values expected under steady state conditions.
14. CO, NMHC, NMNEHC, and HCHO are the maximum values expected under steady state conditions. NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
15. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
16. CO2 tolerance is ± 2.5%. CH4 tolerance is ± 26.0%. Fuel methane number cannot vary more than ± 3.
17. Exhaust Oxygen tolerance is ± 0.5; Lambda tolerance is ± 0.05. Lambda and Exhaust Oxygen level are the result of adjusting the engine to operate at the specified NOx level.
18. LHV rate tolerance is ± 2.5%.
19. Heat rejection to jacket water value displayed includes heat to jacket water alone. Value is based on treated water. Tolerance is ± 10% of full load data.
20. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
21. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
22. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
23. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
24. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
25. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
26. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
27. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (1AC x 1.05) + [0.91 x (1AC + 2AC) x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.
28. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (OC x 1.2) + (2AC x 1.05) + [(1AC + 2AC) x 0.09 x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.

FREE FIELD MECHANICAL & EXHAUST NOISE

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
100	5500	132.1	96.9	100.6	101.0	104.2	105.8	108.6	109.9	110.6	113.8	117.2
75	4125	128.7	90.2	97.7	98.1	100.8	103.3	107.4	107.7	108.5	111.6	114.3
50	2750	125.7	86.2	94.2	94.0	100.8	102.9	106.6	108.3	108.3	110.5	111.5

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
100	5500	117.7	119.4	120.8	120.1	122.0	121.0	119.7	131.3	116.3	108.4	113.8
75	4125	114.4	117.1	119.2	118.4	120.2	118.8	120.6	118.7	112.2	114.8	107.8
50	2750	111.8	114.3	117.9	115.5	117.8	116.7	115.8	112.3	110.6	109.4	103.2

EXHAUST: Sound Power (1/3 Octave Frequencies)

Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
100	5500	144.8	107.2	113.7	115.7	115.1	115.3	121.9	124.5	122.8	122.7	129.3
75	4125	142.9	106.4	112.7	110.8	109.3	111.4	117.5	119.3	118.5	118.0	126.8
50	2750	139.7	105.7	109.3	104.5	103.9	106.7	111.7	113.7	113.3	114.1	124.2

EXHAUST: Sound Power (1/3 Octave Frequencies)

Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
100	5500	130.0	131.0	133.5	133.6	134.8	136.0	136.1	135.5	135.2	134.1	131.9
75	4125	127.1	128.7	130.7	131.8	133.0	134.1	134.9	134.1	133.5	131.5	128.8
50	2750	124.0	125.8	127.4	129.6	131.0	132.0	131.3	130.5	129.1	126.3	123.4

SOUND PARAMETER DEFINITION:

Sound Power Level Data

Sound power is defined as the total sound energy emanating from a source irrespective of direction or distance. Sound power level data is presented under two index headings:
Sound power level -- Mechanical
Sound power level -- Exhaust

Mechanical: Sound power level data is calculated in accordance with ISO 3747. The data is recorded with the exhaust sound source isolated.

Exhaust: Sound power level data is calculated in accordance with ISO 6798 Annex A. Exhaust data is post-catalyst on gas engine ratings labeled as "Integrated Catalyst".

Measurements made in accordance with ISO 3747 and ISO 6798 for mechanical and exhaust sound level only. Frequency bands outside the displayed ranges are not measured, due to physical test, and environmental conditions that affect the accuracy of the measurement. No cooling system noise is included unless specifically indicated. Sound level data is indicative of noise levels recorded on one engine sample in a survey grade 3 environment.

How an engine is packaged, installed and the site acoustical environment will affect the site specific sound levels. For site specific sound level guarantees, sound data collection needs to be done on-site or under similar conditions.

ENGINEERED ENERGY SOLUTIONS

350 kW Gas generator

Aggreko's 350 kW gas generator is engineered to deliver dependable industrial power with lower emissions and reduced operating costs.

Purpose-built for commercial and industrial applications, this unit ensures operational continuity during utility outages, remote deployments, or shifting job site demands.

350 kW

FEATURES

- EPA non-emergency dual fuel certified
- Rich burn combustion
- Dual Axle, electric brake DOT approved trailer
- Brushless alternator w/ automatic voltage regulation
- 1200 Amp electronic-trip switchable main line breaker
- Dual gas leakage detection sensors
- Pusher type cooling fan & vertical air outlet
- Equipped with remote monitoring to aid in performance and reliability
- Ability to operate in extreme ambient temperatures
- A single, fully integrated advanced control system
- Extended service intervals ensure high availability of equipment



BENEFITS

- Often qualifies for air quality incentives or program participation (e.g. in California or Texas)
- Ideal for non-attainment zones due to low NOx / emissions capability with 3-way catalyst
- Speed of deployment & ease of mobility
- Reduced service & precise control
- Paralleling capability & over current protection
- Detection prior to potential hazard
- Reduced noise levels during operation
- Reduced emissions & carbon footprint
- Reduced fuel costs
- Optimized fuel usage
- Lower maintenance needs

The package	
Noise level 60 Hz @ 7 m (23ft)	77 dBA
Power output	328 kW COP / 375 kW PRP
Voltage capability 3 phase	480/277 V (reconfigurable)
Combustion	Rich burn
Speed	1800 rpm (60 Hz)
Emissions certification	EPA non-emergency
Min single step load application	85% @ G1
Max allowable ambient before derate	104° F @ sea level
Max allowable altitude before derate	1000 ft

Physical data	
Enclosure	Canopy
Trailer	Dual axle, electric brake
Weight	18,000 lbs
Dimensions	260 × 102 × 127 inches

Gas energy input	
100% Gas energy input (+/- 2.5% tolerance)	79034 BTU/min (PRP)

Exhaust emissions (post catalyst)	
Specific load	100%
NOx – Oxides of Nitrogen (E695 EPA)	0.068 g/kW-hr
CO - Carbon Monoxide	0.020 g/kW-hr
NMHC - Non-Methane Hydrocarbons	0.079 g/kW-hr
THC - Total Hydrocarbons	1.195 g/kW-hr
CO2 - Carbon Dioxid	725.9 g/kW-hr

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Gas Composition and Properties

EnLink Midstream

Effective January 1, 2026 09:00 - January 18, 2038 21:14

Source #: 973000F
Name: CORRAL CANYON CPR FUEL

Component	Mole %	Liquid Content	Mass %
Carbon Dioxide (CO2)	0.0000		0.0000
Nitrogen (N2)	1.1570		1.9668
Methane (C1)	96.7540		94.1900
Ethane (C2)	2.0540	0.5473	3.7479
Propane (C3)	0.0330	0.0091	0.0883
Isobutane (IC4)	0.0010	0.0003	0.0035
n-Butane (NC4)	0.0010	0.0003	0.0035
Isopentane (IC5)	0.0000	0.0000	0.0000
n-Pentane (NC5)	0.0000	0.0000	0.0000
n-Hexane (C6)	0.0000	0.0000	0.0000
n-Heptane (C7)	0.0000	0.0000	0.0000
n-Octane (C8)	0.0000	0.0000	0.0000
n-Nonane (C9)	0.0000	0.0000	0.0000
Decanes Plus (C10+)	0.0000	0.0000	0.0000
Argon (Ar)			
Carbon Monoxide (CO)			
Hydrogen (H2)			
Oxygen (O2)	0.0000		0.0000
Helium (He)			
Water (H2O)			
Hydrogen Sulfide (H2S)	0.0000		0.0000
Totals	100.0000	0.5560	100.0000

Property	Total Sample
Pressure Base	14.65
Temperature Base	60
HCDP @ Sample Pressure	
Cricondentherm	
HV, Dry @ Base P, T	1013.34
HV, Sat @ Base P, T	995.60
HV, Sat @ Sample P, T	1012.69
Relative Density	0.5699

C10+: 100

Sample

Date: 01/20/2026 Type: Spot
Tech: BRANDON SULLINS
Pressure: 154.0 psi Temp.: 37 °F
Gauge: Gauge H2O: 0.00
Atm. Pressure: H2S: 0 ppm

Remarks:

Analysis

Date: 01/20/2026 Instrument:
Cylinder: MGT-131
Tech:

Remarks:

*** End of Report ***

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Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES (NO_x) AND CARBON MONOXIDE (CO) FROM NATURAL GAS COMBUSTION[a]

Combustor Type (MMBtu/hr Heat Input) [SCC]	NO_x[b]		CO	
	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
Large Wall-Fired Boilers (>100) [1-01-006-01, 1-02-006-01, 1-03-006-01]				
Uncontrolled (Pre-NSPS)[c]	280	A	84	B
Uncontrolled (Post-NSPS)[c]	190	A	84	B
Controlled - Low NO_x burners	140	A	84	B
Controlled - Flue gas recirculation	100	D	84	B
Small Boilers (<100) [1-01-006-02, 1-02-006-02, 1-03-006-02, 1-03-006-03]				
Uncontrolled	100	B	84	B
Controlled - Low NO_x burners	50	D	84	B
Controlled - Low NO_x burners/Flue gas recirculation	32	C	84	B
Tangential-Fired Boilers (All Sizes) [1-01-006-04]				
Uncontrolled	170	A	24	C
Controlled - Flue gas recirculation	76	D	98	D
Residential Furnaces (<0.3) [No SCC]				
Uncontrolled	94	B	40	B

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. To convert from $lb/10^6$ scf to $kg/10^6$ m^3, multiply by 16. Emission factors are based on an average natural gas higher heating value of 1,020 Btu/scf. To convert from $lb/10^6$ scf to lb/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. SCC = Source Classification Code. ND = no data. NA = not applicable.

[b] Expressed as NO_2. For large and small wall fired boilers with SNCR control, apply a 24 percent reduction to the appropriate NO_x emission factor. For tangential-fired boilers with SNCR control, apply a 13 percent reduction to the appropriate NO_x emission factor.

[c] NSPS=New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction modification, or reconstruction after June 19, 1984.

TABLE 1.4-2. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM NATURAL GAS COMBUSTION[a]

Pollutant	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
CO_2[b]	120,000	A
Lead	0.0005	D
N_2O (Uncontrolled)	2.2	E
N_2O (Controlled-low-NO_X burner)	0.64	E
PM (Total)[c]	7.6	D
PM (Condensable)[c]	5.7	D
PM (Filterable)[c]	1.9	B
SO_2[d]	0.6	A
TOC	11	B
Methane	2.3	B
VOC	5.5	C

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6$ m^3, multiply by 16. To convert from $lb/10^6$ scf to 1b/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. TOC = Total Organic Compounds. VOC = Volatile Organic Compounds.

[b] Based on approximately 100% conversion of fuel carbon to CO_2. $CO_2[lb/10^6 \text{ scf}] = (3.67)(CON)(C)(D)$, where CON = fractional conversion of fuel carbon to CO_2, C = carbon content of fuel by weight (0.76), and D = density of fuel, 4.2×10^4 $lb/10^6$ scf.

[c] All PM (total, condensible, and filterable) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here may be used to estimate PM_{10}, $PM_{2.5}$ or PM_1 emissions. Total PM is the sum of the filterable PM and condensible PM. Condensible PM is the particulate matter collected using EPA Method 202 (or equivalent). Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 (or equivalent) sampling train.

[d] Based on 100% conversion of fuel sulfur to SO_2. Assumes sulfur content is natural gas of 2,000 grains/10^6 scf. The SO_2 emission factor in this table can be converted to other natural gas sulfur contents by multiplying the SO_2 emission factor by the ratio of the site-specific sulfur content (grains/10^6 scf) to 2,000 grains/10^6 scf.

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION[a]

CAS No.	Pollutant	Emission Factor (lb/10^6 scf)	Emission Factor Rating
91-57-6	2-Methylnaphthalene[b, c]	2.4E-05	D
56-49-5	3-Methylcholanthrene[b, c]	<1.8E-06	E
	7,12-Dimethylbenz(a)anthracene[b,c]	<1.6E-05	E
83-32-9	Acenaphthene[b,c]	<1.8E-06	E
203-96-8	Acenaphthylene[b,c]	<1.8E-06	E
120-12-7	Anthracene[b,c]	<2.4E-06	E
56-55-3	Benz(a)anthracene[b,c]	<1.8E-06	E
71-43-2	Benzene[b]	2.1E-03	B
50-32-8	Benzo(a)pyrene[b,c]	<1.2E-06	E
205-99-2	Benzo(b)fluoranthene[b,c]	<1.8E-06	E
191-24-2	Benzo(g,h,i)perylene[b,c]	<1.2E-06	E
207-08-9	Benzo(k)fluoranthene[b,c]	<1.8E-06	E
106-97-8	Butane	2.1E+00	E
218-01-9	Chrysene[b,c]	<1.8E-06	E
53-70-3	Dibenzo(a,h)anthracene[b,c]	<1.2E-06	E
25321-22-6	Dichlorobenzene[b]	1.2E-03	E
74-84-0	Ethane	3.1E+00	E
206-44-0	Fluoranthene[b,c]	3.0E-06	E
86-73-7	Fluorene[b,c]	2.8E-06	E
50-00-0	Formaldehyde[b]	7.5E-02	B
110-54-3	Hexane[b]	1.8E+00	E
193-39-5	Indeno(1,2,3-cd)pyrene[b,c]	<1.8E-06	E
91-20-3	Naphthalene[b]	6.1E-04	E
109-66-0	Pentane	2.6E+00	E
85-01-8	Phenanathrene[b,c]	1.7E-05	D
74-98-6	Propane	1.6E+00	E

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION (Continued)

CAS No.	Pollutant	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
129-00-0	Pyrene[b, c]	5.0E-06	E
108-88-3	Toluene[b]	3.4E-03	C

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6$ m^3, multiply by 16. To convert from $lb/10^6$ scf to lb/MMBtu, divide by 1,020. Emission Factors preceeded with a less-than symbol are based on method detection limits.

[b] Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.

[c] HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.

[d] The sum of individual organic compounds may exceed the VOC and TOC emission factors due to differences in test methods and the availability of test data for each pollutant.

Table 3.2-2. UNCONTROLLED EMISSION FACTORS FOR 4-STROKE LEAN-BURN ENGINES[a]
(SCC 2-02-002-54)

Pollutant	Emission Factor (lb/MMBtu)[b] (fuel input)	Emission Factor Rating
Criteria Pollutants and Greenhouse Gases		
NO_x[c] 90 - 105% Load	4.08 E+00	B
NO_x[c] <90% Load	8.47 E-01	B
CO[c] 90 - 105% Load	3.17 E-01	C
CO[c] <90% Load	5.57 E-01	B
CO_2[d]	1.10 E+02	A
SO_2[e]	5.88 E-04	A
TOC[f]	1.47 E+00	A
Methane[g]	1.25 E+00	C
VOC[h]	1.18 E-01	C
PM10 (filterable)[i]	7.71 E-05	D
PM2.5 (filterable)[i]	7.71 E-05	D
PM Condensable[j]	9.91 E-03	D
Trace Organic Compounds		
1,1,2,2-Tetrachloroethane[k]	<4.00 E-05	E
1,1,2-Trichloroethane[k]	<3.18 E-05	E
1,1-Dichloroethane	<2.36 E-05	E
1,2,3-Trimethylbenzene	2.30 E-05	D
1,2,4-Trimethylbenzene	1.43 E-05	C
1,2-Dichloroethane	<2.36 E-05	E
1,2-Dichloropropane	<2.69 E-05	E
1,3,5-Trimethylbenzene	3.38 E-05	D
1,3-Butadiene[k]	2.67E-04	D
1,3-Dichloropropene[k]	<2.64 E-05	E
2-Methylnaphthalene[k]	3.32 E-05	C
2,2,4-Trimethylpentane[k]	2.50 E-04	C
Acenaphthene[k]	1.25 E-06	C

Table 3.2-2. UNCONTROLLED EMISSION FACTORS FOR 4-STROKE LEAN-BURN ENGINES
(Continued)

Pollutant	Emission Factor (lb/MMBtu)[b] (fuel input)	Emission Factor Rating
Acenaphthylene[k]	5.53 E-06	C
Acetaldehyde[k,l]	8.36 E-03	A
Acrolein[k,l]	5.14 E-03	A
Benzene[k]	4.40 E-04	A
Benzo(b)fluoranthene[k]	1.66 E-07	D
Benzo(e)pyrene[k]	4.15 E-07	D
Benzo(g,h,i)perylene[k]	4.14 E-07	D
Biphenyl[k]	2.12 E-04	D
Butane	5.41 E-04	D
Butyr/Isobutyraldehyde	1.01 E-04	C
Carbon Tetrachloride[k]	<3.67 E-05	E
Chlorobenzene[k]	<3.04 E-05	E
Chloroethane	1.87 E-06	D
Chloroform[k]	<2.85 E-05	E
Chrysene[k]	6.93 E-07	C
Cyclopentane	2.27 E-04	C
Ethane	1.05 E-01	C
Ethylbenzene[k]	3.97 E-05	B
Ethylene Dibromide[k]	<4.43 E-05	E
Fluoranthene[k]	1.11 E-06	C
Fluorene[k]	5.67 E-06	C
Formaldehyde[k,l]	5.28 E-02	A
Methanol[k]	2.50 E-03	B
Methylcyclohexane	1.23 E-03	C
Methylene Chloride[k]	2.00 E-05	C
n-Hexane[k]	1.11 E-03	C
n-Nonane	1.10 E-04	C

Table 3.2-2. UNCONTROLLED EMISSION FACTORS FOR 4-STROKE LEAN-BURN ENGINES
(Continued)

Pollutant	Emission Factor (lb/MMBtu)[b] (fuel input)	Emission Factor Rating
n-Octane	3.51 E-04	C
n-Pentane	2.60 E-03	C
Naphthalene[k]	7.44 E-05	C
PAH[k]	2.69 E-05	D
Phenanthrene[k]	1.04 E-05	D
Phenol[k]	2.40 E-05	D
Propane	4.19 E-02	C
Pyrene[k]	1.36 E-06	C
Styrene[k]	<2.36 E-05	E
Tetrachloroethane[k]	2.48 E-06	D
Toluene[k]	4.08 E-04	B
Vinyl Chloride[k]	1.49 E-05	C
Xylene[k]	1.84 E-04	B

[a] Reference 7. Factors represent uncontrolled levels. For NO_x, CO, and PM10, "uncontrolled" means no combustion or add-on controls; however, the factor may include turbocharged units. For all other pollutants, "uncontrolled" means no oxidation control; the data set may include units with control techniques used for NOx control, such as PCC and SCR for lean burn engines, and PSC for rich burn engines. Factors are based on large population of engines. Factors are for engines at all loads, except as indicated. SCC = Source Classification Code. TOC = Total Organic Compounds. PM-10 = Particulate Matter ≤ 10 microns (μm) aerodynamic diameter. A "<" sign in front of a factor means that the corresponding emission factor is based on one-half of the method detection limit.

[b] Emission factors were calculated in units of (lb/MMBtu) based on procedures in EPA Method 19. To convert from (lb/MMBtu) to (lb/10^6 scf), multiply by the heat content of the fuel. If the heat content is not available, use 1020 Btu/scf. To convert from (lb/MMBtu) to (lb/hp-hr) use the following equation:

$$\text{lb/hp-hr} = (\text{lb/MMBtu})(\text{heat input, MMBtu/hr})(1/\text{operating HP, 1/hp})$$

[c] Emission tests with unreported load conditions were not included in the data set.

[d] Based on 99.5% conversion of the fuel carbon to CO_2. CO_2 [lb/MMBtu] = (3.67)(%CON)(C)(D)(1/h), where %CON = percent conversion of fuel carbon to CO_2, C = carbon content of fuel by weight (0.75), D = density of fuel, 4.1 E+04 lb/10^6 scf, and

Table 3.2-3. UNCONTROLLED EMISSION FACTORS FOR 4-STROKE RICH-BURN ENGINES[a]
(SCC 2-02-002-53)

Pollutant	Emission Factor (lb/MMBtu)[b] (fuel input)	Emission Factor Rating
Criteria Pollutants and Greenhouse Gases		
NO_x[c] 90 - 105% Load	2.21 E+00	A
NO_x[c] <90% Load	2.27 E+00	C
CO[c] 90 - 105% Load	3.72 E+00	A
CO[c] <90% Load	3.51 E+00	C
CO_2[d]	1.10 E+02	A
SO_2[e]	5.88 E-04	A
TOC[f]	3.58 E-01	C
Methane[g]	2.30 E-01	C
VOC[h]	2.96 E-02	C
PM10 (filterable)[i,j]	9.50 E-03	E
PM2.5 (filterable)[j]	9.50 E-03	E
PM Condensable[k]	9.91 E-03	E
Trace Organic Compounds		
1,1,2,2-Tetrachloroethane[l]	2.53 E-05	C
1,1,2-Trichloroethane[l]	<1.53 E-05	E
1,1-Dichloroethane	<1.13 E-05	E
1,2-Dichloroethane	<1.13 E-05	E
1,2-Dichloropropane	<1.30 E-05	E
1,3-Butadiene[l]	6.63 E-04	D
1,3-Dichloropropene[l]	<1.27 E-05	E
Acetaldehyde[l,m]	2.79 E-03	C
Acrolein[l,m]	2.63 E-03	C
Benzene[l]	1.58 E-03	B
Butyr/isobutyraldehyde	4.86 E-05	D
Carbon Tetrachloride[l]	<1.77 E-05	E

Table 3.2-3. UNCONTROLLED EMISSION FACTORS FOR 4-STROKE RICH-BURN ENGINES (Concluded)

Pollutant	Emission Factor (lb/MMBtu)[b] (fuel input)	Emission Factor Rating
Chlorobenzene[l]	<1.29 E-05	E
Chloroform[l]	<1.37 E-05	E
Ethane[n]	7.04 E-02	C
Ethylbenzene[l]	<2.48 E-05	E
Ethylene Dibromide[l]	<2.13 E-05	E
Formaldehyde[l,m]	2.05 E-02	A
Methanol[l]	3.06 E-03	D
Methylene Chloride[l]	4.12 E-05	C
Naphthalene[l]	<9.71 E-05	E
PAH[l]	1.41 E-04	D
Styrene[l]	<1.19 E-05	E
Toluene[l]	5.58 E-04	A
Vinyl Chloride[l]	<7.18 E-06	E
Xylene[l]	1.95 E-04	A

[a] Reference 7. Factors represent uncontrolled levels. For NO_x, CO, and PM-10, "uncontrolled" means no combustion or add-on controls; however, the factor may include turbocharged units. For all other pollutants, "uncontrolled" means no oxidation control; the data set may include units with control techniques used for NOx control, such as PCC and SCR for lean burn engines, and PSC for rich burn engines. Factors are based on large population of engines. Factors are for engines at all loads, except as indicated. SCC = Source Classification Code. TOC = Total Organic Compounds. PM10 = Particulate Matter $\leq$ 10 microns (μm) aerodynamic diameter. A "<" sign in front of a factor means that the corresponding emission factor is based on one-half of the method detection limit.

[b] Emission factors were calculated in units of (lb/MMBtu) based on procedures in EPA Method 19. To convert from (lb/MMBtu) to (lb/10^6 scf), multiply by the heat content of the fuel. If the heat content is not available, use 1020 Btu/scf. To convert from (lb/MMBtu) to (lb/hp-hr) use the following equation:

$$\text{lb/hp-hr} = (\text{lb/MMBtu})(\text{heat input, MMBtu/hr})(\text{1/operating HP, 1/hp})$$

[c] Emission tests with unreported load conditions were not included in the data set.

[d] Based on 99.5% conversion of the fuel carbon to CO_2. CO_2 [lb/MMBtu] = (3.67)(%CON)(C)(D)(1/h), where %CON = percent conversion of fuel carbon to CO_2,

C = carbon content of fuel by weight (0.75), D = density of fuel, 4.1 E+04 lb/10^6 scf, and h = heating value of natural gas (assume 1020 Btu/scf at 60°F).

[e] Based on 100% conversion of fuel sulfur to SO_2. Assumes sulfur content in natural gas of 2,000 gr/10^6 scf.

[f] Emission factor for TOC is based on measured emission levels from 6 source tests.

[g] Emission factor for methane is determined by subtracting the VOC and ethane emission factors from the TOC emission factor.

[h] VOC emission factor is based on the sum of the emission factors for all speciated organic compounds. Methane and ethane emissions were not measured for this engine category.

[i] No data were available for uncontrolled engines. PM10 emissions are for engines equipped with a PCC.

[j] Considered $\leq$ 1 μm in aerodynamic diameter. Therefore, for filterable PM emissions, PM10(filterable) = PM2.5(filterable).

[k] No data were available for condensable emissions. The presented emission factor reflects emissions from 4SLB engines.

[l] Hazardous Air Pollutant as defined by Section 112(b) of the Clean Air Act.

[m] For rich-burn engines, no interference is suspected in quantifying aldehyde emissions. The presented emission factors are based on FTIR and CARB 430 emissions data measurements.

[n] Ethane emission factor is determined by subtracting the VOC emission factor from the NMHC emission factor.

Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

Emission Factor	Surface Silt Content, %	Mean Vehicle Weight		Mean Vehicle Speed		Mean No. of Wheels	Surface Moisture Content, %
		Mg	ton	km/hr	mph		
Industrial Roads (Equation 1a)	1.8-25.2	1.8-260	2-290	8-69	5-43	4-17[a]	0.03-13
Public Roads (Equation 1b)	1.8-35	1.4-2.7	1.5-3	16-88	10-55	4-4.8	0.03-13

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range

The "NG_process_gas_LPG_PM_factors" spreadsheet was originally created per request by R5 states during a call in late January 2010
It was modified in March 30, 2012 by adding additional natural gas-related combustion SCCs and is provided for SLT to consider for 2011 reporting

This spreadsheet contains PM emission factors for natural gas, process gas, and LPG. It includes PM25-FIL, PM10-FIL, PM-CON, PM25-PRI and PM10-PRI
For these fuels, the efs were revised dramatically around 2004 using some preliminary data from Ron Myers EPA
Ron Myers is the lead on the development of a condensible PM test method
The method is not final but some preliminary data was available and the data showed the current AP42 factors were off by a factor of 10 or 20.
The emission inventory group in EPA used the preliminary data to adjust the 2002 NEI and has also used these for the 2008 NEI.

This spreadsheet is an attempt to pull together the PM factors for gaseous fuel into one place.
These emission factors can be considered for inventory calculations when there are no site-specific data available.
Site specific test data are preferred over these or any emission factors. Where available, site specific information should be used.

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LPG Boiler EFs after ERTAC review version 2, conducted by Roy Huntley, US EPA, 0809.xls: originally, this was called:
spreadsheet_LPG emissions factors after ERTAC review session version 2 0808_xls

Efs for natural gas-fired boilers

poll code	value	Units_NUM	Units_DEN	
VOC	5.5	LB	E6FT3	EF from AP 42 section 1.4 for boilers
NOX	100	LB	E6FT3	EF from AP 42 section 1.4, for small boiler, uncontrolled
CO	84	LB	E6FT3	EF from AP 42 section 1.4 for boilers
SO2	0.6	LB	E6FT3	EF from AP 42 section 1.4 for boilers
PM10-FIL	0.2	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Derived by difference
PM10-PRI	0.52	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls"
PM25-FIL	0.11	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Derived by difference
PM25-PRI	0.43	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls"
PM-CON	0.32	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Used ratio in ss (0.0566) and multiplied by Pmcon in AP42 (5.7)
NH3	0.49	LB	E6FT3	EF from EIIP report Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources, April 2004

PM Efs for natural gas-fired turbines/recip engines, recip engines assumed same as turbines due to lack of data

poll code	value	Units_NUM	Units_DEN	
PM10-FIL	0.17	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Derived by difference
PM10-PRI	0.31	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls"
PM25-FIL	0.05	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Derived by difference
PM25-PRI	0.19	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls"
PM-CON	0.14	LB	E6FT3	PM ef from EPA spreadsheet "Final table with Natural Gas Adjustment factors Nov 21 2006.xls". Used ratio in ss (0.0566) and multiplied by Pmcon in AP42 (4.79)

File entitled "Final table with NG adjustment factors Nov 21 2006.xls" is in this file on another worksheet tab entitled "Final Table with NG Adjustments"

Conversion factors used to convert E6FT3 to E3GAL and E3BBL

value	Units_NUM	Units_DEN	Description
			BTU content for LPG, from AP42 footnotes in section 1.5. table
96.75	MMBTU	E3GAL	1.51, arith average of propane and butane
42	GAL	BBL	Converts gallons to barrels, From AP42 appendix A
1020	MMBTU	E6FT3	BTU content for natural gas

Efs for LPG based on NG AP42 emission factors

poll code	value	Units_NUM	Units_DEN	value	Units_NUM	Units_DEN
VOC	0.52169	LB	E3GAL	21.911029	LB	E3BBL
NOX	14.2279	LB	E3GAL	597.57353	LB	E3BBL
CO	7.96765	LB	E3GAL	334.64118	LB	E3BBL
SO2	0.05691	LB	E3GAL	2.3902941	LB	E3BBL
PM10-FIL	0.01897	LB	E3GAL	0.7967647	LB	E3BBL
PM10-PRI	0.04932	LB	E3GAL	2.0715882	LB	E3BBL
PM25-FIL	0.01043	LB	E3GAL	0.4382206	LB	E3BBL
PM25-PRI	0.04079	LB	E3GAL	1.7130441	LB	E3BBL
PM-CON	0.03035	LB	E3GAL	1.2748235	LB	E3BBL
NH3	0.04648	LB	E3GAL	1.9520735	LB	E3BBL

Note the choice of two units
Emission factors (Efs) in box are the ones I recommend. Based on ng AP42 efs and converted to appropriate units for LPG as you can tell by looking at the equations
The LPG efs are based on those of natural gas because of the similarities between LPG and ng and the lack of data from LPG sources.
The NOX ef is 1.5 times higher than that of ng due to footnote in table 1.5-1 in section 1.5 of AP42
SCCs that these efs are appropriate for are in a separate Worksheet in this file.

Note that these efs for LPG are recommended for industrial and commercial/institutional use
For residential LPG, I recommend the same as above for all pollutants except for CO and NOX
CO becomes 3.8 lb/E3GAL and Nox becomes 13.4

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Originally the purpose of this worksheet was to document the derivation of the LPG emission factors for boilers and reciprocating engines
due to the adjustment we were making regarding the condensible fraction. In March 2012, we added more information regarding documentation



October 2000
RG-109 (Draft)

Air Permit Technical Guidance for Chemical Sources:

Flares and Vapor Oxidizers

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Air Permits Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Stream	Destruction/Removal Efficiency (DRE)		
VOC	98 percent (generic) 99 percent for compounds containing no more than 3 carbons that contain no elements other than carbon and hydrogen in addition to the following compounds: methanol, ethanol, propanol, ethylene oxide and propylene oxide		
H_2S	98 percent		
NH_3	case by case		
CO	case by case		
Air Contaminants	**Emission Factors**		
thermal NO_x	steam-assist:	high Btu	0.0485 lb/MMBtu
		low Btu	0.068 lb/MMBtu
	other:	high Btu	0.138 lb/MMBtu
		low Btu	0.0641 lb/MMBtu
fuel NO_x	NO_x is 0.5 wt percent of inlet NH_3, other fuels case by case		
CO	steam-assist:	high Btu	0.3503 lb/MMBtu
		low Btu	0.3465 lb/MMBtu
	other:	high Btu	0.2755 lb/MMBtu
		low Btu	0.5496 lb/MMBtu
PM	none, required to be smokeless		
SO_2	100 percent S in fuel to SO_2		

*The only exeption ot this is if inorganics might be emitted from the flare. In the case of landfills, the AP-42 PM factor may be used. In other cases, the emissions should be based on the composition of the waste stream routed to the flare.

40 CFR Appendix Table C-1 to Subpart C of Part 98 - Default CO2 Emission Factors and High Heat Values for Various Types of Fuel

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CFR

Table C-1 to Subpart C of Part 98—Default CO^2 Emission Factors and High Heat Values for Various Types of Fuel

DEFAULT CO^2 EMISSION FACTORS AND HIGH HEAT VALUES FOR VARIOUS TYPES OF FUEL

Fuel type	Default high heat value	Default CO 2 emission factor
Coal and coke	mmBtu/short ton	kg CO 2/mmBtu
Anthracite	25.09	103.69
Bituminous	24.93	93.28

Subbituminous	17.25	97.17
Lignite	14.21	97.72
Coal Coke	24.80	113.67
Mixed (Commercial sector)	21.39	94.27
Mixed (Industrial coking)	26.28	93.90
Mixed (Industrial sector)	22.35	94.67
Mixed (Electric Power sector)	19.73	95.52
Natural gas	mmBtu/scf	kg CO 2/mmBtu
(Weighted U.S. Average)	1.026 × 10−3	53.06
Petroleum products—liquid	mmBtu/gallon	kg CO 2/mmBtu
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.96
Distillate Fuel Oil No. 4	0.146	75.04
Residual Fuel Oil No. 5	0.140	72.93
Residual Fuel Oil No. 6	0.150	75.10
Used Oil	0.138	74.00
Kerosene	0.135	75.20
Liquefied petroleum gases (LPG) [1]	0.092	61.71
Propane [1]	0.091	62.87
Propylene [2]	0.091	67.77
Ethane [1]	0.068	59.60
Ethanol	0.084	68.44
Ethylene [2]	0.058	65.96
Isobutane [1]	0.099	64.94
Isobutylene [1]	0.103	68.86
Butane [1]	0.103	64.77
Butylene [1]	0.105	68.72
Naphtha (<401 deg F)	0.125	68.02
Natural Gasoline	0.110	66.88

Other Oil (>401 deg F)	0.139	76.22
Pentanes Plus	0.110	70.02
Petrochemical Feedstocks	0.125	71.02
Special Naphtha	0.125	72.34
Unfinished Oils	0.139	74.54
Heavy Gas Oils	0.148	74.92
Lubricants	0.144	74.27
Motor Gasoline	0.125	70.22
Aviation Gasoline	0.120	69.25
Kerosene-Type Jet Fuel	0.135	72.22
Asphalt and Road Oil	0.158	75.36
Crude Oil	0.138	74.54
Petroleum products—solid	mmBtu/short ton	kg CO 2/mmBtu.
Petroleum Coke	30.00	102.41.
Petroleum products—gaseous	mmBtu/scf	kg CO 2/mmBtu.
Propane Gas	2.516 × 10−3	61.46.
Other fuels—solid	mmBtu/short ton	kg CO 2/mmBtu
Municipal Solid Waste	9.95 [3]	90.7
Tires	28.00	85.97
Plastics	38.00	75.00
Other fuels—gaseous	mmBtu/scf	kg CO 2/mmBtu
Blast Furnace Gas	0.092 × 10−3	274.32
Coke Oven Gas	0.599 × 10−3	46.85
Fuel Gas [4]	1.388 × 10−3	59.00
Biomass fuels—solid	mmBtu/short ton	kg CO 2/mmBtu
Wood and Wood Residuals (dry basis) [5]	17.48	93.80
Agricultural Byproducts	8.25	118.17
Peat	8.00	111.84
Solid Byproducts	10.39	105.51

Biomass fuels—gaseous	mmBtu/scf	kg CO 2/mmBtu
Landfill Gas	0.485 × 10−3	52.07
Other Biomass Gases	0.655 × 10−3	52.07
Biomass Fuels—Liquid	mmBtu/gallon	kg CO 2/mmBtu
Ethanol	0.084	68.44
Biodiesel (100%)	0.128	73.84
Rendered Animal Fat	0.125	71.06
Vegetable Oil	0.120	81.55

[1] The HHV for components of LPG determined at 60 °F and saturation pressure with the exception of ethylene.

[2] Ethylene HHV determined at 41 °F (5 °C) and saturation pressure.

[3] Use of this default HHV is allowed only for: (a) Units that combust MSW, do not generate steam, and are allowed to use Tier 1; (b) units that derive no more than 10 percent of their annual heat input from MSW and/or tires; and (c) small batch incinerators that combust no more than 1,000 tons of MSW per year.

[4] Reporters subject to subpart X of this part that are complying with § 98.243(d) or subpart Y of this part may only use the default HHV and the default CO^2 emission factor for fuel gas combustion under the conditions prescribed in § 98.243(d)(2)(i) and (d)(2)(ii) and § 98.252(a)(1) and (a)(2), respectively. Otherwise, reporters subject to subpart X or subpart Y shall use either Tier 3 (Equation C-5) or Tier 4.

[5] Use the following formula to calculate a wet basis HHV for use in Equation C-1: HHV^w = ((100 − M)/100)*HHV^d where HHV^w = wet basis HHV, M = moisture content (percent) and HHV^d = dry basis HHV from Table C-1.

[78 FR 71950, Nov. 29, 2013, as amended at 81 FR 89252, Dec. 9, 2016]

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40 CFR Appendix Table C-2 to Subpart C of Part 98 - Default CH4 and N2O Emission Factors for Various Types of Fuel

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CFR

Table C-2 to Subpart C of Part 98—Default CH^4 and N^2O Emission Factors for Various Types of Fuel

Fuel type	Default CH 4 emission factor (kg CH 4/mmBtu)	Default N2O emission factor (kg N2O/mmBtu)
Coal and Coke (All fuel types in Table C-1)	1.1 × 10−02	1.6 × 10−03
Natural Gas [1]	1.0 × 10− 03	1.0 × 10− 04
Petroleum Products (All fuel types in Table C-1)	3.0 × 10−03	6.0 × 10−04

Fuel Gas	3.0 × 10−03	6.0 × 10−04
Other Fuels—Solid	3.2 × 10−02	4.2 × 10−03
Blast Furnace Gas	2.2 × 10−05	1.0 × 10−04
Coke Oven Gas	4.8 × 10−04	1.0 × 10−04
Biomass Fuels—Solid (All fuel types in Table C-1, except wood and wood residuals)	3.2 × 10−02	4.2 × 10−03
Wood and wood residuals	7.2 × 10−03	3.6 × 10−03
Biomass Fuels—Gaseous (All fuel types in Table C-1)	3.2 × 10−03	6.3 × 10−04
Biomass Fuels—Liquid (All fuel types in Table C-1)	1.1 × 10−03	1.1 × 10−04

Note: Those employing this table are assumed to fall under the IPCC definitions of the "Energy Industry" or "Manufacturing Industries and Construction". In all fuels except for coal the values for these two categories are identical. For coal combustion, those who fall within the IPCC "Energy Industry" category may employ a value of 1g of CH^4/mmBtu.

[1] Reporters subject to subpart W of this part may only use the default CH4 emission factor for natural gas-fired combustion units that are not reciprocating internal combustion engines or gas turbines. For natural gas-fired reciprocating internal combustion engines or gas turbines, at facilities subject to subpart W of this part, reporters must use a CH^4 emission factor determined in accordance with § 98.233(z)(4).

[78 FR 71952, Nov. 29, 2013, as amended at 81 FR 89252, Dec. 9, 2016; 89 FR 42220, May 14, 2024]

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NattyGas Lab

10700 FM 307
Midland, TX 79706
432-686-2719
www.nattygaslab.com

Gas Analysis Report

Method	GPA 2286	**Analyzed On**	10/21/2025
Analysis #	9871		
Cylinder #	-	**Analyzed By**	Alex Mata

Customer Information

Attn: Syed Tirmzi
303 W Wall St #202
Midland, TX 79701

Sample Information

Producer:	OneOK	**Sampled By:**	Chris Sanchez
Well/Lease:	Red Raider Station	**Sample Date:**	10/15/2025
Station #:	Inlet Gas	**Sample Pressure:**	12 psig
County:	-	**Sample Temperature:**	78 F
Sample Type:	Spot	**Sample Method:**	Purge
Remarks:	-	**Field H2S:**	0 ppm

Base Condition: 14.65 psia and 60° F

Physical Constants per GPA 2145-16

Component	Mole %	Wt %	GPM
H2S	0.0000	0.0000	
Nitrogen	0.9144	1.1631	
Carbon Dioxide	0.1222	0.2442	
Methane	76.6784	55.8560	
Ethane	11.7722	16.0731	3.143
Propane	5.5994	11.2114	1.540
Iso-Butane	0.8258	2.1794	0.270
N-Butane	1.9306	5.0951	0.608
Iso-Pentane	0.4908	1.6079	0.179
N-Pentane	0.5692	1.8647	0.206
2,2-Dimethylbutane	0.0079	0.0309	0.003
2,3-Dimethylbutane & Cyclopentane	0.0353	0.1381	0.014
2-Methylpentane	0.1348	0.5275	0.055
3-Methylpentane	0.0726	0.2841	0.030
N-Hexane	0.1879	0.7352	0.077
2,2-Dimethylpentane	0.0028	0.0127	0.001
Methylcyclopentane	0.0757	0.2893	0.027
Benzene	0.0146	0.0518	0.004
3,3-Dimethylpentane	0.0016	0.0073	0.001
Cyclohexane	0.0874	0.3340	0.030
2-Methylhexane	0.0300	0.1365	0.014
2,3-Dimethylpentane	0.0074	0.0337	0.003
1,1-Dimethylcyclopentane	0.0066	0.0294	0.003
3-Methylhexane	0.0367	0.1670	0.017
1,t-3-Dimethylcyclopentane	0.0136	0.0606	0.006
1,c-3-Dimethylcyclopentane	0.0141	0.0629	0.006

2,2,4-Trimethylpentane	0.0167	0.0866	0.009
N-Heptane	0.0680	0.3094	0.031
2,2-Dimethylhexane	0.0015	0.0078	0.001
Methylcyclohexane	0.0939	0.4186	0.038
2,5-Dimethylhexane	0.0020	0.0104	0.001
2,4-Dimethylhexane & Ethylcyclopentane	0.0050	0.0259	0.003
1,t-2,c-4-Trimethylcyclopentane	0.0063	0.0321	0.003
1,t-2,c-3-Trimethylcyclopentane	0.0045	0.0229	0.002
Toluene	0.0224	0.0937	0.008
2,3-Dimethylhexane	0.0022	0.0092	0.001
1,1,2-Trimethylcyclopentane	0.0003	0.0015	0.000
2-Methylheptane	0.0146	0.0757	0.008
4-Methylheptane	0.0043	0.0223	0.002
3,4-Dimethylhexane	0.0008	0.0041	0.000
3-Methylheptane	0.0071	0.0368	0.004
1,c-3-Dimethylcyclohexane	0.0013	0.0066	0.001
1,c-2-t-3-Trimethylcyclopentane	0.0006	0.0031	0.000
1,c-2-t-4-Trimethylcyclopentane	0.0005	0.0025	0.000
1,t-4-Dimethylcyclohexane	0.0125	0.0637	0.006
2,2,5-Trimethylhexane	0.0047	0.0274	0.003
1,1-Dimethylcyclohexane	0.0029	0.0148	0.001
2,2,4-Trimethylhexane	0.0004	0.0023	0.000
Cycloheptane	0.0011	0.0049	0.000
N-Octane	0.0174	0.0902	0.009
1,t-3-Dimethylcyclohexane	0.0049	0.0250	0.002
2,2 Dimethylheptane	0.0008	0.0047	0.001
2,4 Dimethylheptane	0.0025	0.0146	0.001
2,6 Dimethylheptane	0.0026	0.0151	0.002
2,5 Dimethylheptane	0.0011	0.0064	0.001
Ethylcyclohexane	0.0072	0.0367	0.003
3,3 Dimethylheptane	0.0026	0.0151	0.001
2,3,4-Trimethylhexane	0.0003	0.0017	0.000
Ethylbenzene	0.0011	0.0053	0.000
2,3-Dimethylheptane	0.0021	0.0122	0.001
M-Xylene	0.0085	0.0410	0.003
P-Xylene	0.0050	0.0241	0.002
3,4-Dimethylheptane	0.0000	0.0000	0.000
2-Methyloctane	0.0025	0.0146	0.001
4-Methyloctane	0.0002	0.0012	0.000
3-Methyloctane	0.0007	0.0041	0.000
O-Xylene	0.0020	0.0096	0.001
1,1,2-Trimethylcyclohexane	0.0005	0.0029	0.000
Isobutylcyclopentane	0.0008	0.0046	0.000
Unidentified Nonanes	0.0053	0.0309	0.003
N-Nonane	0.0065	0.0379	0.004
Isopropylbenzene	0.0007	0.0038	0.000
Cyclooctane	0.0014	0.0071	0.001

Propylcyclohexane	0.0029	0.0166	0.002
N-Propylbenzene	0.0007	0.0038	0.000
1-3-5-Trimethylbenzene	0.0009	0.0049	0.000
t-butylbenzene	0.0011	0.0067	0.001
Unidentified Decanes	0.0059	0.0381	0.004
N-Decane	0.0017	0.0110	0.001
C11+	0.0045	0.0319	0.003
Total	**100.0000**	**100.0000**	**6.404**

Total Gross Heating Value (BTU/ft^3)			**C6+ Mole %**	**C6+ Wt%**
Dry	Wet		1.0970	4.7051
1307.8	1284.9	Ideal		
1312.9	1290.6	Real		

	GPM (Real)
C2 +	6.404
C3 +	3.262
C4 +	1.722
C5 +	0.844
C6 +	0.459

Dry Compressibility Factor (Z)

0.9961

Dry Specific Gravity (air=1.000)

0.7604	Ideal
0.7631	Real

NattyGas Lab

10700 FM 307
Midland, TX 79706
432-686-2719
www.nattygaslab.com

NGL Analysis Report

Method	GPA 2186	**Analyzed On**	10/20/2025
Analysis #	9790		
Cylinder #	169799	**Analyzed By**	Alex Mata

Customer Information

Attn: Chris Sanchez
303 W Wall St #202
Midland, TX 79701

Sample Information

Producer:	OneOk	**Sampled By:**	Chris Sanchez	
Location:	Red Raider	**Sample Date/Time:**	10/15/2025	
Station #:	Condensate	**Sample Pressure:**	90	psig
County:	-	**Sample Temp:**	88	F
Sample Type:	Spot	**Sample Method:**	Constant Pressure	
Remarks:	-	**Cylinder Pressure:**	100	psig

Base Condition: 14.65 psia and 60° F

Physical Constants per GPA 2145-16

Component	Mol %	Wt %	L.V. %
Nitrogen	0.0130	0.0040	0.0034
Carbon Dioxide	0.0076	0.0037	0.0031
Methane	2.4526	0.4300	1.0051
Ethane	2.2770	0.7482	1.4721
Propane	3.7649	1.8140	2.5079
Iso-Butane	1.3471	0.8556	1.0656
N-Butane	4.7534	3.0192	3.6226
Iso-Pentane	3.0671	2.4182	2.7116
N-Pentane	4.9333	3.8896	4.3230
2,2-Dimethylbutane	0.1173	0.1105	0.1184
2,3-Dimethylbutane & Cyclopentane	0.6171	0.5811	0.6116
2-Methylpentane	3.0857	2.9059	3.0964
3-Methylpentane	1.9117	1.8003	1.8859
N-Hexane	6.2819	5.9158	6.2446
2,2-Dimethylpentane	0.1462	0.1601	0.1654
Methylcyclopentane	2.9238	2.6890	2.5010
2,4-Dimethylpentane	0.0290	0.0318	0.0329
Benzene	0.4699	0.4011	0.3179
3,3-Dimethylpentane	0.1061	0.1162	0.1166
Cyclohexane	4.4745	4.1152	3.6813
2-Methylhexane	2.4418	2.6738	2.7431
2,3-Dimethylpentane	0.5592	0.6123	0.6137
1,1-Dimethylcyclopentane	0.7743	0.8308	0.7671
3-Methylhexane	2.7479	3.0090	3.0503
1,t-3-Dimethylcyclopentane	1.0808	1.1597	1.0789
1,c-3-Dimethylcyclopentane	1.1678	1.2530	1.1719

2,2,4-Trimethylpentane	1.3729	1.7138	1.7252
N-Heptane	7.2408	7.9287	8.0755
Methylcyclohexane	9.7347	10.4451	9.4593
1,1,3-Trimethylcyclopentane	0.3963	0.4860	0.4525
2,5-Dimethylhexane	0.2788	0.3480	0.3493
2,4-Dimethylhexane & Ethylcyclopentane	0.6341	0.7915	0.7885
3,3-Dimethylhexane	0.8383	1.0464	1.0274
1,t-2,c-3-Trimethylcyclopentane	0.5930	0.7272	0.6722
2,3,4-Trimethylpentane	0.0197	0.0246	0.0238
Toluene	2.1140	2.1286	1.7114
2,3-Dimethylhexane	0.3139	0.3161	0.3832
1,1,2-Trimethylcyclopentane	0.0311	0.0381	0.0344
2-Methylheptane	2.5761	3.2157	3.2112
4-Methylheptane	0.5489	0.6852	0.6775
3,4-Dimethylhexane	0.1309	0.1634	0.1584
3-Methylheptane	1.2993	1.6219	1.6016
3-Ethylhexane	0.1603	0.2001	0.1955
1,c-3-Dimethylcyclohexane	2.0398	2.5013	2.2739
1,t-4-Dimethylcyclohexane	0.8004	0.9815	0.8967
1,1-Dimethylcyclohexane	0.4676	0.5734	0.5118
2,2,4-Trimethylhexane	0.0700	0.0981	0.0955
Cycloheptane	0.1860	0.1996	0.1715
N-Octane	3.3419	4.1717	4.1387
1,t-3-Dimethylcyclohexane	0.6155	0.7548	0.6715
2,2-Dimethylheptane	0.1351	0.1894	0.1857
2,4-Dimethylheptane	0.4246	0.5951	0.5802
2,6-Dimethylheptane	0.5078	0.7117	0.6985
2,5-Dimethylheptane	0.1853	0.2597	0.2526
Ethylcyclohexane	1.2777	1.5668	1.3856
3,3-Dimethylheptane	0.4641	0.6505	0.6245
2,3,4-Trimethylhexane	0.0599	0.0840	0.0793
Ethylbenzene	0.1503	0.1744	0.1402
2,3-Dimethylheptane	0.3694	0.5177	0.4976
M-Xylene	1.5579	1.8074	1.4582
P-Xylene	0.7007	0.8129	0.6582
3,4-Dimethylheptane	0.0078	0.0109	0.0104
2-Methyloctane	0.4653	0.6522	0.6372
4-Methyloctane	0.0348	0.0488	0.0471
3-Methyloctane	0.1250	0.1752	0.1694
O-Xylene	0.3017	0.3500	0.2773
1,1,2-Trimethylcyclohexane	0.0694	0.0957	0.0836
Unidentified Nonanes	1.2351	1.7311	1.6802
N-Nonane	1.0668	1.4952	1.4512
Isopropylbenzene	0.1135	0.1491	0.1206
Isopropylhexane	0.1901	0.2623	0.2280
n-Butylcyclopentane	0.4582	0.6321	0.5618
n-Propylbenzene	0.0996	0.1308	0.1058

M-Ethyltoluene	0.1614	0.2120	0.1710
P-Ethyltoluene	0.1935	0.2542	0.2057
4-Methylnonane	0.0875	0.1360	0.1295
2-Methylnonane	0.0828	0.1287	0.1235
t-Butylbenzene	0.2132	0.3127	0.2517
t-Butylcyclohexane	0.0494	0.0757	0.0650
Unidentified Decanes	0.6741	1.0481	1.0002
N-Decane	0.2868	0.4459	0.4255
Undecanes	0.6665	1.1385	1.0720
Dodecanes	0.1690	0.3146	0.2926
Tridecanes+	0.0604	0.1217	0.1122
Total	**100.0000**	**100.0000**	**100.0000**

Sample Calculations

Absolute Density (lb/gal) =	**5.85**
Ft^3 vapor/gallon @ 14.696 =	**24.33**
API Gravity @ 60°F =	**70.2**
Molecular Weight =	**91.51**
SG @ 60°F (H2O=1) =	**0.7015**
Gas BTU/gallon liquid =	**119856**
Gas BTU/lb liquid =	**20493**

Sample C6+ Calculations

Absolute Density (lb/gal) =	**6.10**
Ft^3 vapor/gallon @ 14.696 =	**22.61**
API Gravity @ 60°F =	**62.0**
Molecular Weight =	**102.66**
SG @ 60°F (H2O=1) =	**0.7313**
Gas BTU/gallon liquid =	**124533**
Gas BTU/lb liquid =	**20425**
C6+ Mole % =	**77.3840**
C6+ WT % =	**86.8175**
C6+ LV % =	**83.2856**