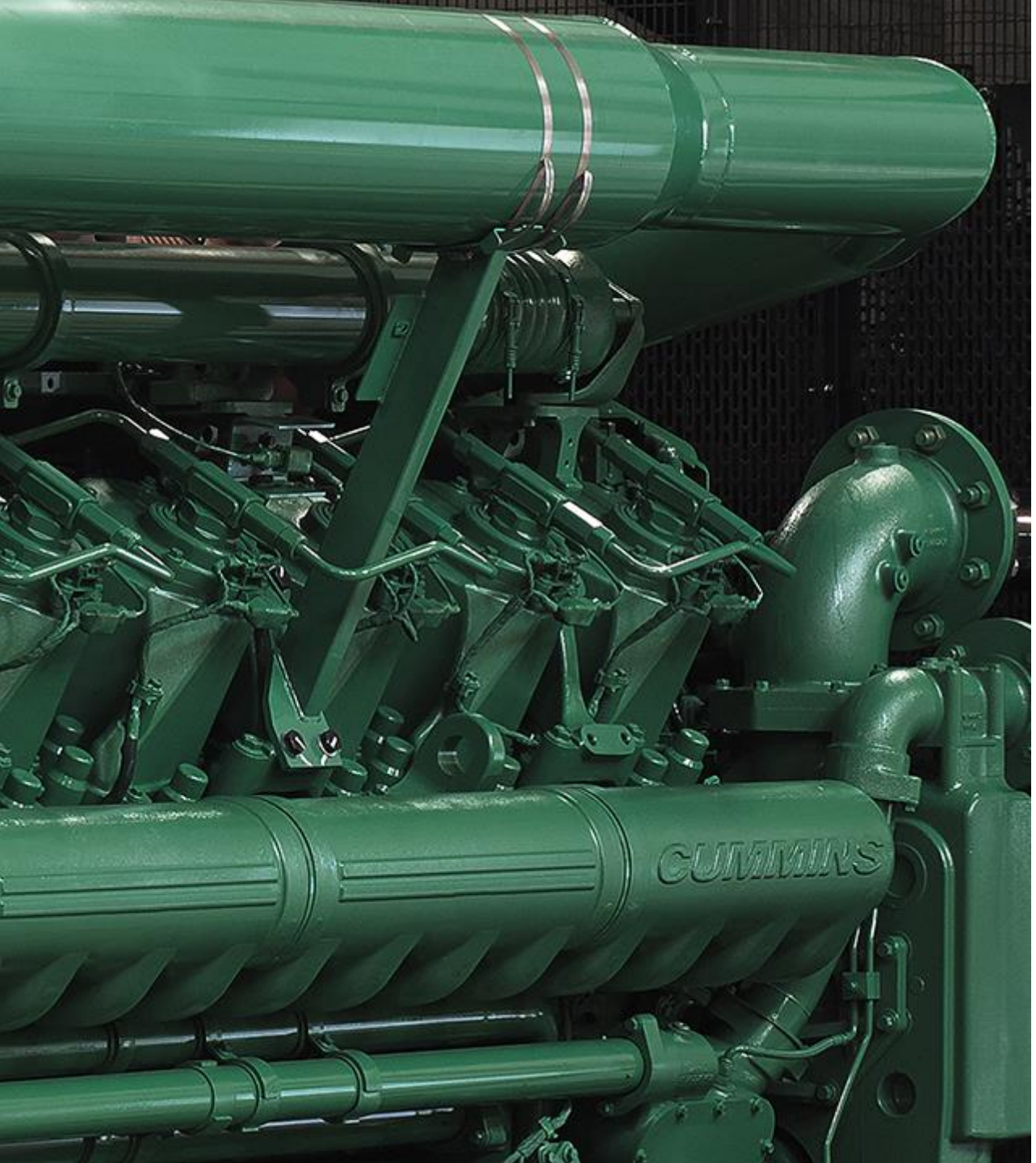

Emissions and Air Permitting Requirements for Standby Generator Sets

PowerHour webinar series for consulting engineers

Experts you trust. Excellence you count on.

June 25, 2019 11:00 PDT / 13:00 CDT

(1PDH issued by Cummins)

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Tom Bakritzes,
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Disclaimer

The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when it doubt, reach out to the Authority Having Jurisdiction.

Course Objectives

Emissions and Air Permitting Requirements for Standby Generator Sets

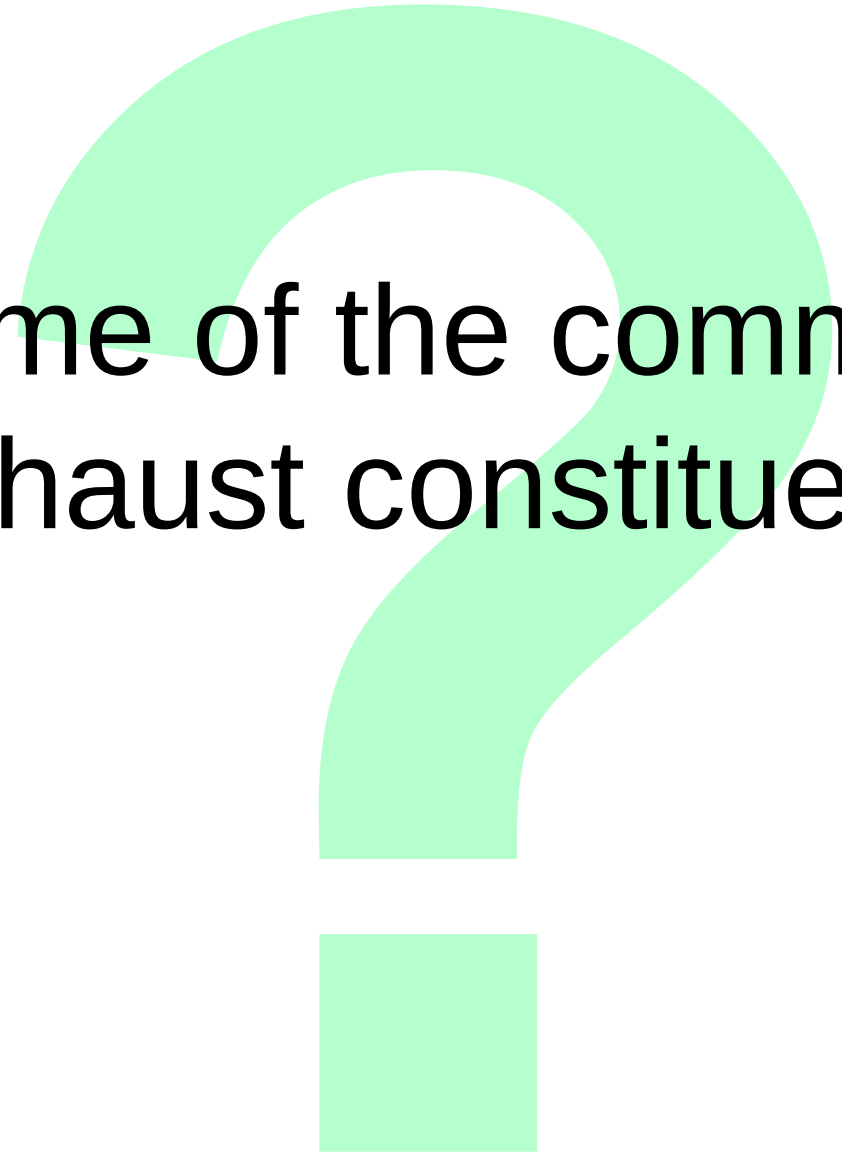
Air permitting for standby generator sets can vary wildly from site to site and when misunderstood can have a major impact on project success. Although EPA regulations have stabilized and are thought to be well understood, ever-increasing local requirements are changing the criticality of air permitting for engine-driven generator sets.

This course will provide a brief overview of regulated emissions constituents and their formation in order to provide a foundational understanding of engine emissions. Next, the EPA's New Source Performance Standards (NSPS) will be reviewed as it relates to both compression ignited (diesel) and spark ignited (natural gas or propane) engine equipped generator sets. Participants will gain an awareness of common pitfalls related to emissions permitting and will be introduced to various strategies employed to meet local emissions regulations.

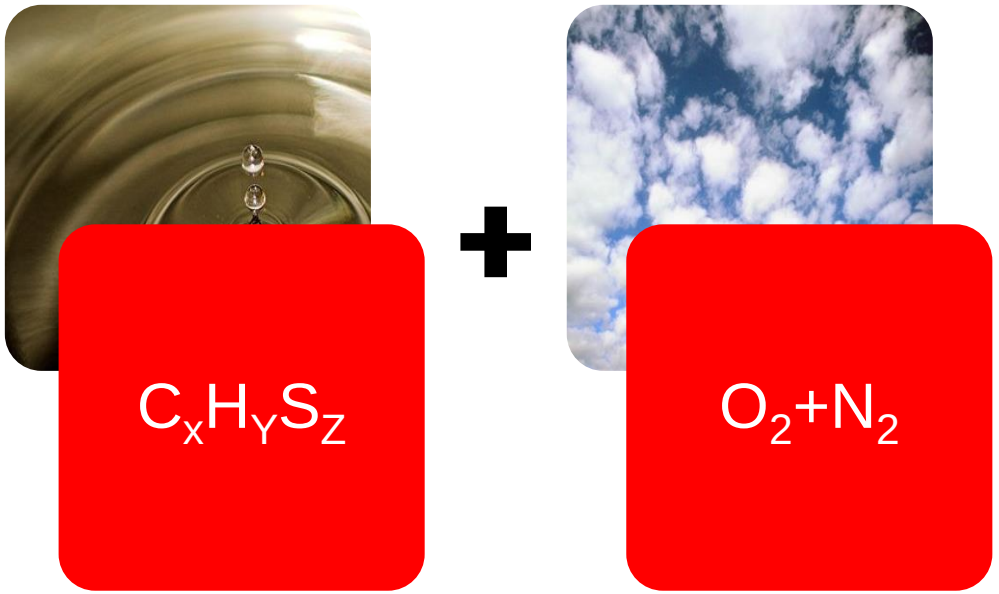
After completing this course, participants will be able to:

- Recognize commonly regulated exhaust emissions constituents.
- Describe EPA emissions requirements for diesel and gaseous standby generator sets.
- Identify common requirements for permitting engine-driven generator sets.

What are some of the commonly regulated exhaust constituents?



Exhaust Emissions Formation



Exhaust Emissions Formation

$C_xH_YS_Z$

+

O_2+N_2

=

CO_2+H_2O+
O_2+N_2

Fuel

Air

Major Exhaust Constituents

Exhaust Emissions Formation

$C_xH_YS_Z$

+

O_2+N_2

=

$CO_2+H_2O+O_2+N_2$

+

$NO_x+HC+CO+SO_x+C$

Fuel

Air

Major Exhaust Constituents

Trace Exhaust Components

Exhaust Emissions Formation

	What is it?	How is it formed?	CI	SI
NO_x	Oxides of nitrogen (NO and NO_2)	Forms at high in-cylinder temperatures, most prominent during high engine load.	✓	✓
HC	Over 100 different types of hydrocarbons	Product of incomplete combustion, most prominent during low engine load.	✓	✓
NMHC	Non-methane hydrocarbons, subset of total hydrocarbons	Product of incomplete combustion, dependent on fuel composition.	✓	✓
VOC	Volatile organic compounds	Primarily hydrocarbons but may include other compounds.		✓
PM	Anything that is trapped on or condenses onto a filter	Most prominent during low load operation.	✓	
CO	Carbon monoxide	Product of imperfect combustion, most prominent during low engine load.	✓	✓
SO_x	Oxides of sulfur (SO and SO_2)	Product of combustion process when sulfur is present. Increases linearly with fuel consumption.	✓	✓

New Source Performance Standards (NSPS) for Compression-Ignited and Spark-Ignited engines

What is NSPS?

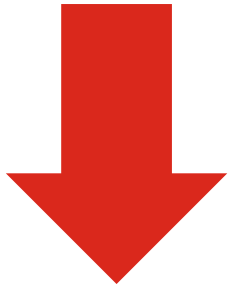
New Source Performance Standards

What is NSPS?

New Source Performance Standards

What is NSPS?

New Source Performance Standards



Source of emissions, when manufactured or installed

What is NSPS?

New Source Performance Standards

What is NSPS?

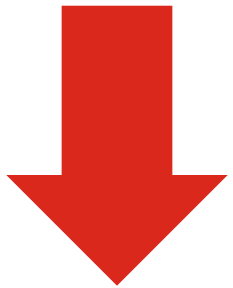
New Source Performance Standards

Emissions limits, operational guidelines and test methodologies

What is NSPS?

New Source Performance Standards

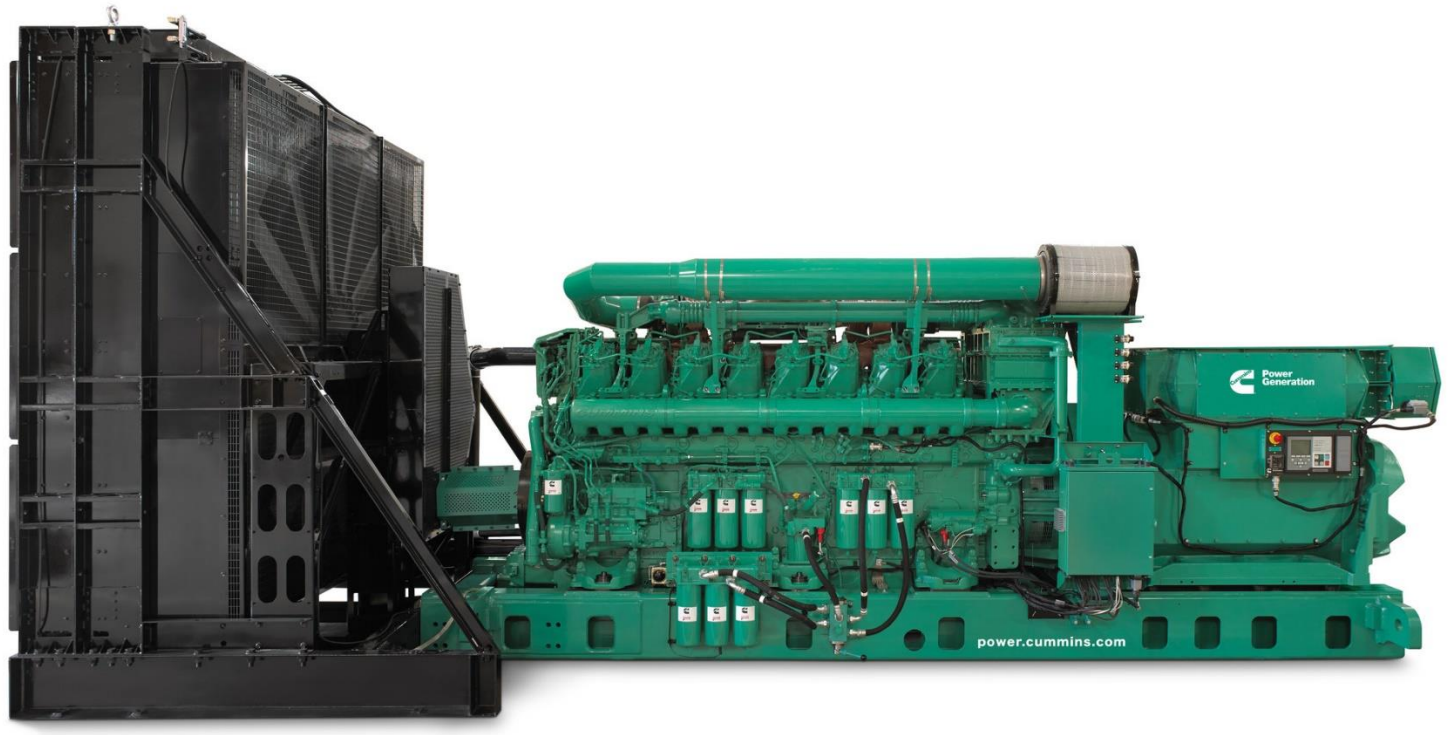
Emissions limits, operational guidelines and test methodologies



Source of emissions, when manufactured or installed

Requirements for EPA Certified Engines

- Engines are certified, not generator sets.



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kW	(hp)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0-7	0-10	(7.5) / 8.0 / 0.40												
8-18	11-24	(7.5) / 6.6 / 0.40												
19-36	25-48	(7.5) / 5.5 / 0.30			(4.7) / 5.5 / 0.03 **Emergency: Stay at previous tier**									
37-55	49-74	*Optional T4i 0.30 PM*			(4.7) / 5.0 / 0.03 **Emergency: Stay at previous tier**									
56-129	75-173	Tier 3		3.4 / 0.19 / 5.0 / 0.02 **Tier 3**			0.40 / 0.19 / 5.0 / 0.02 **Tier 3**							
130-560	174-751	Tier 3	2.0 / 0.19 / 3.5 / 0.02 **Tier 3**			0.40 / 0.19 / 3.5 / 0.02 **Tier 3**								
> 560	> 751	Tier 2	3.5 / 0.40 / 3.5 / 0.10 **Tier 2** *0.67 / 0.40 / 3.5 / 0.10 (a)*				3.5 / 0.19 / 3.5 / 0.04 **Tier 2** *0.67 / 0.19 / 3.5 / 0.03 (b)*							
		T2	T3	Tier 4 Interim			Tier 4 Final							

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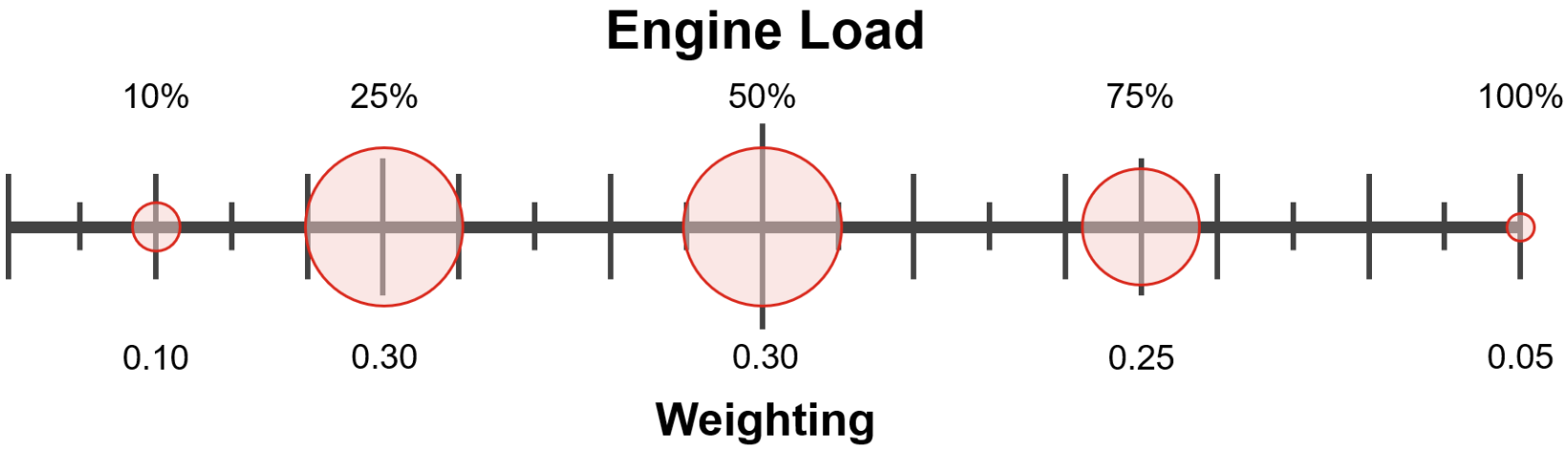

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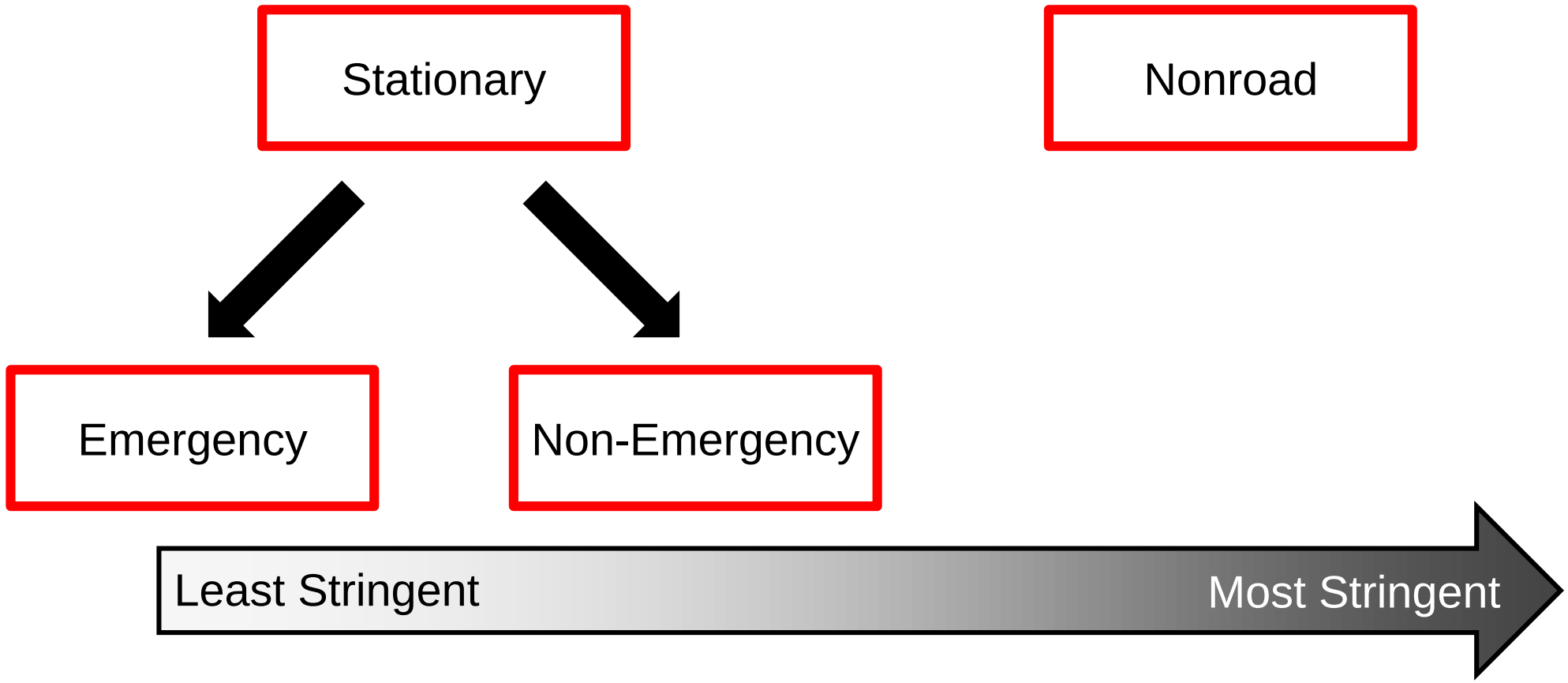
- Emissions levels are evaluated on a standardized test cycle including engine load and pollutant weighting following a specific test method in a test-cell environment.
- Engines and emissions control devices must be certified as a complete solution by the engine manufacture (field upfit or third-party installations cannot meet certification requirements).

EPA Engine Usage Designations



Stationary and Nonroad Engines

Stationary

- On site for at least 12 consecutive months.
- Unable to be mounted on a trailer or be mobilized.

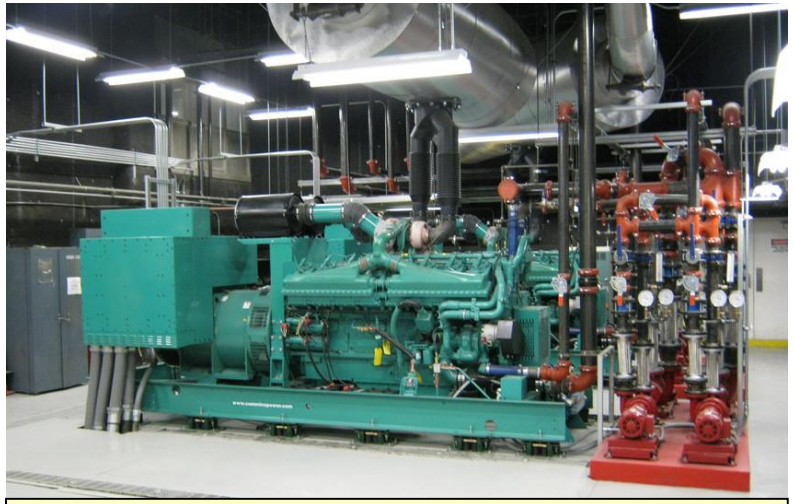
Nonroad

- No movement or operation restrictions.
- Must comply with most stringent emissions requirements.

Stationary Emergency Operation

- Emergency standby (safe evacuation, life support)
- Legally required standby (fire–fighting operations)
- Optional standby (could cause an economic loss)

Standby power system including seven C2000 D6 (2000 kWe) generator sets.



Standby system including two DQGAA (1250 kWe) and one DQGAB (1500 kWe).

Stationary Emergency Operation

- Unlimited use during emergencies.

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- Up to 100 hours per year allowed for:
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- Up to 100 hours per year allowed for:
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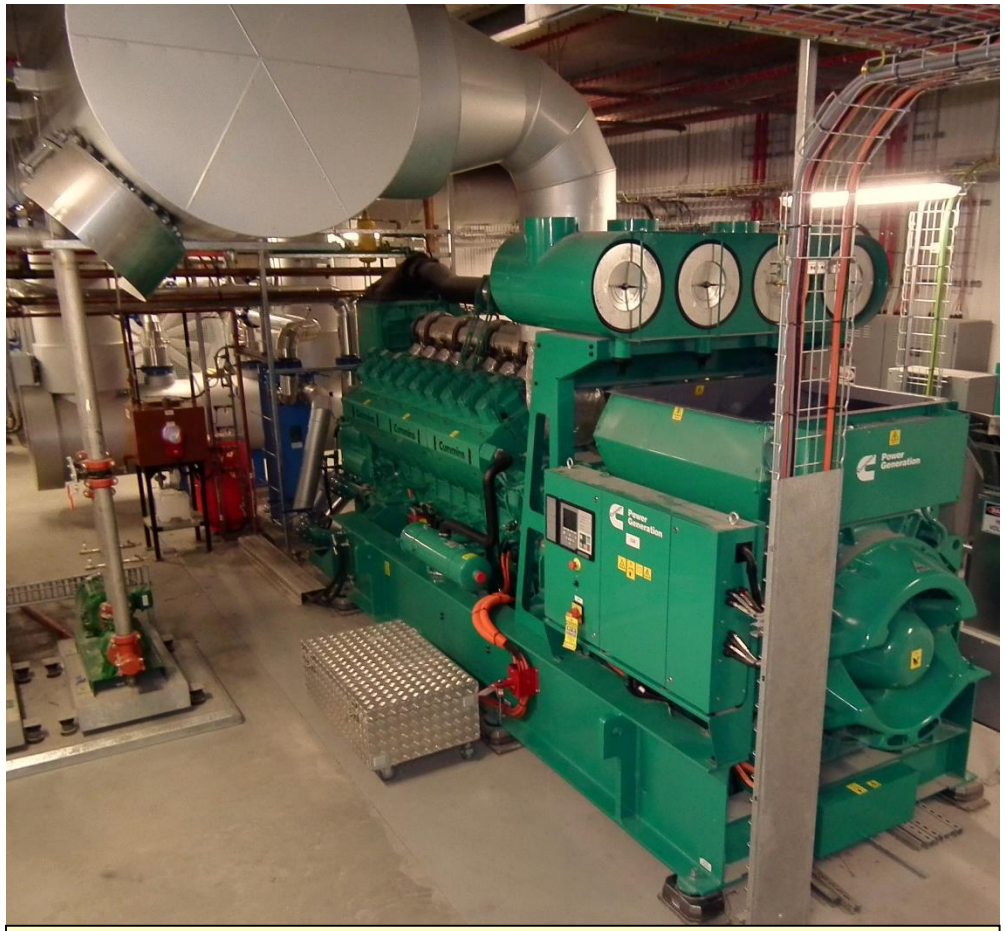
  - Up to 50 hours per year for non-emergency operation (restrictions apply)
  - Emergency Demand Response (EDR) allowance vacated in May 2015

Spec Note Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary emergency engines.

Stationary Non-Emergency Operation

Remote mining site including two DQGAS (1500 kWe) generator sets.



Combined heat and power project producing steam with one C2000 N5C (2000 kWe) generator set.

Stationary Non-Emergency Operation

- Demand Response
- Peak shaving (reduce or flatten peak electricity use)
- Rate curtailment (favorable energy rates)
- Interruptible rate programs (favorable energy rates)
- Continuous base load (constant power to utility grid)
- Co-generation (capture and use waste heat)
- Prime power generator set (to be used as a primary source of power)

Spec Note Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary non-emergency engines.

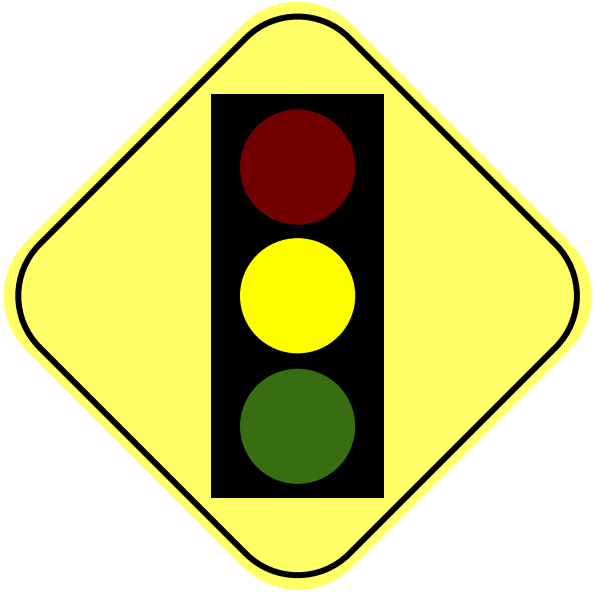
Other Industry Standards

NEC (NFPA 70): Practical safeguarding of persons and property from hazards arising from the use of electricity. Contains provisions that are considered necessary for safety.

- Emergency Systems (700)
- Legally Required Standby Systems (701)
- Optional Standby Systems (702)
- Critical Operations Power Systems (708)

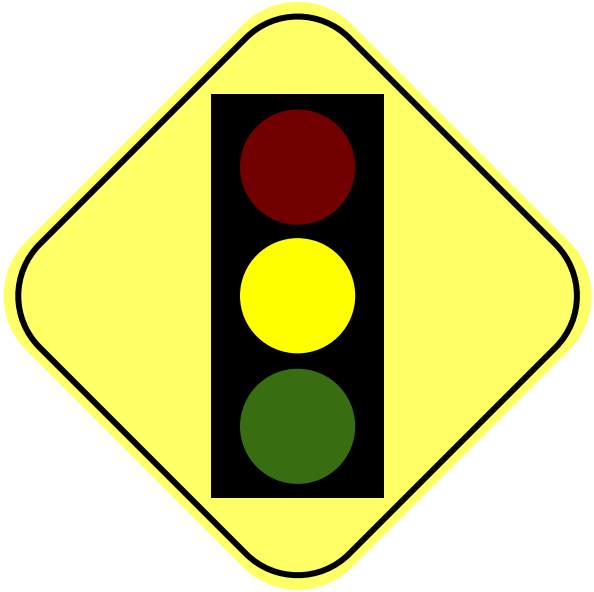
ISO 8528: Standard for reciprocating internal combustion engine driven alternating current generator sets.

- Emergency Standby Power (ESP)
- Limited Time Prime Power (LTP)
- Prime Rated Power (PRP)
- Continuous Operating Power (COP)



Spec Note Specify EPA certification requirements, ISO power ratings and NEC load types served independently.

Other Industry Standards



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Cummins Power Topic #6240:
Understanding ISO 8528-1 Generator Set Ratings

Spec Note Specify EPA certification requirements, ISO power ratings and NEC load types served independently.

Concept Check

The EPA designates certification requirements for _____ based on _____ and _____.

a) Generator Sets, Electrical Output, NEC Load Type
b) Engines, Brake Power, Usage
c) Power production equipment, Alternator rating, ISO 8528 rating

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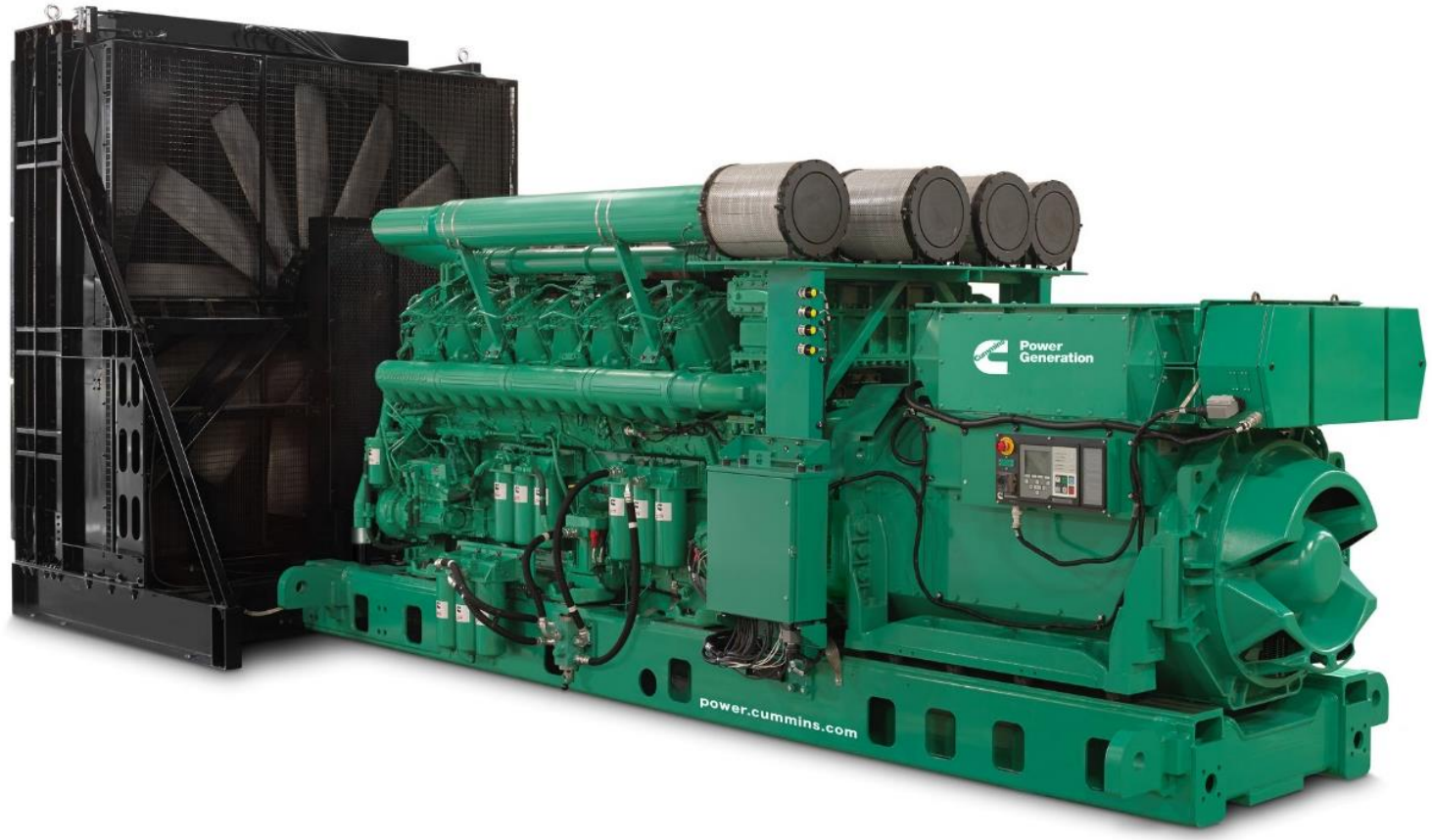
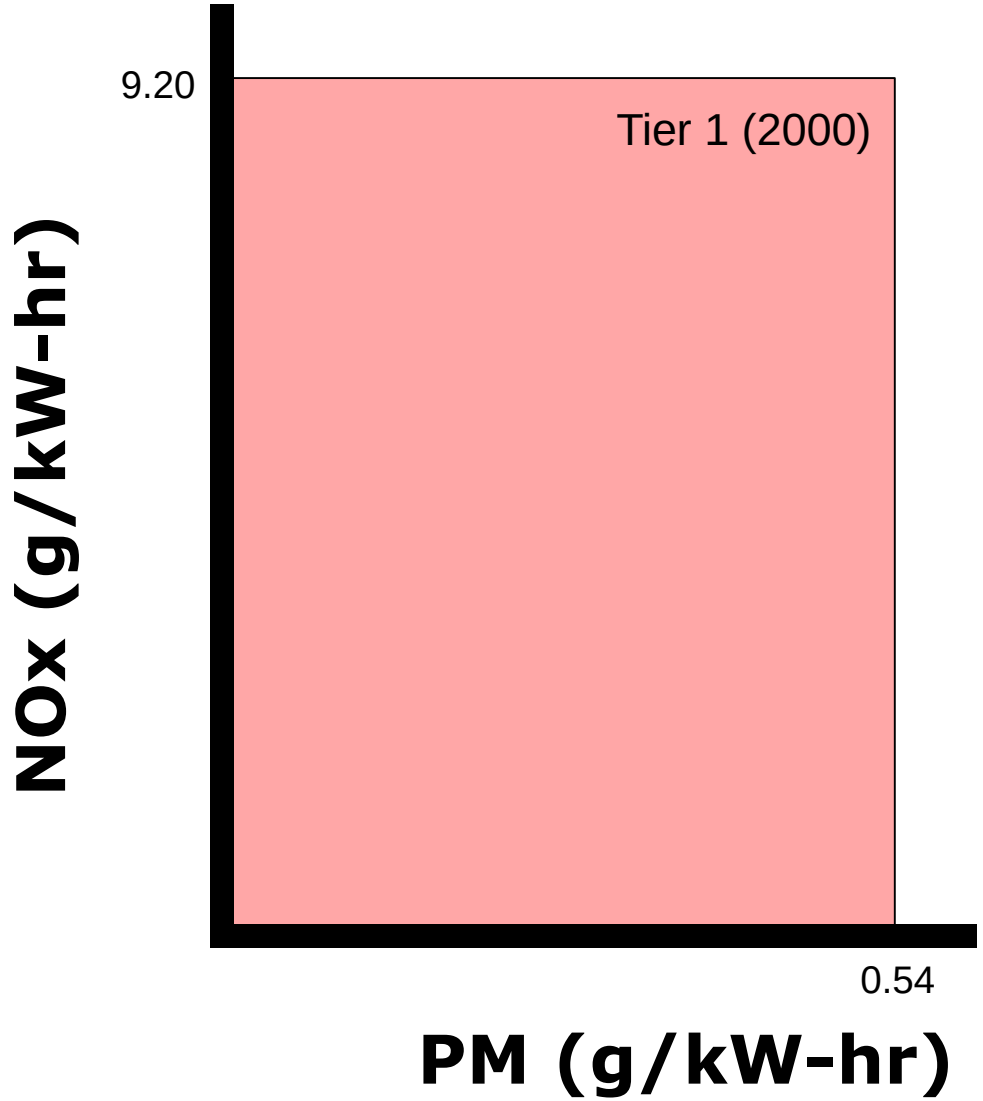
New Source Performance Standards (NSPS) for Stationary CI engines

Title 40, Part 60: Subpart IIII



Evolution of NSPS CI Engine Regulations

EPA Non-Road / Stationary Non-Emergency Engines >751 HP



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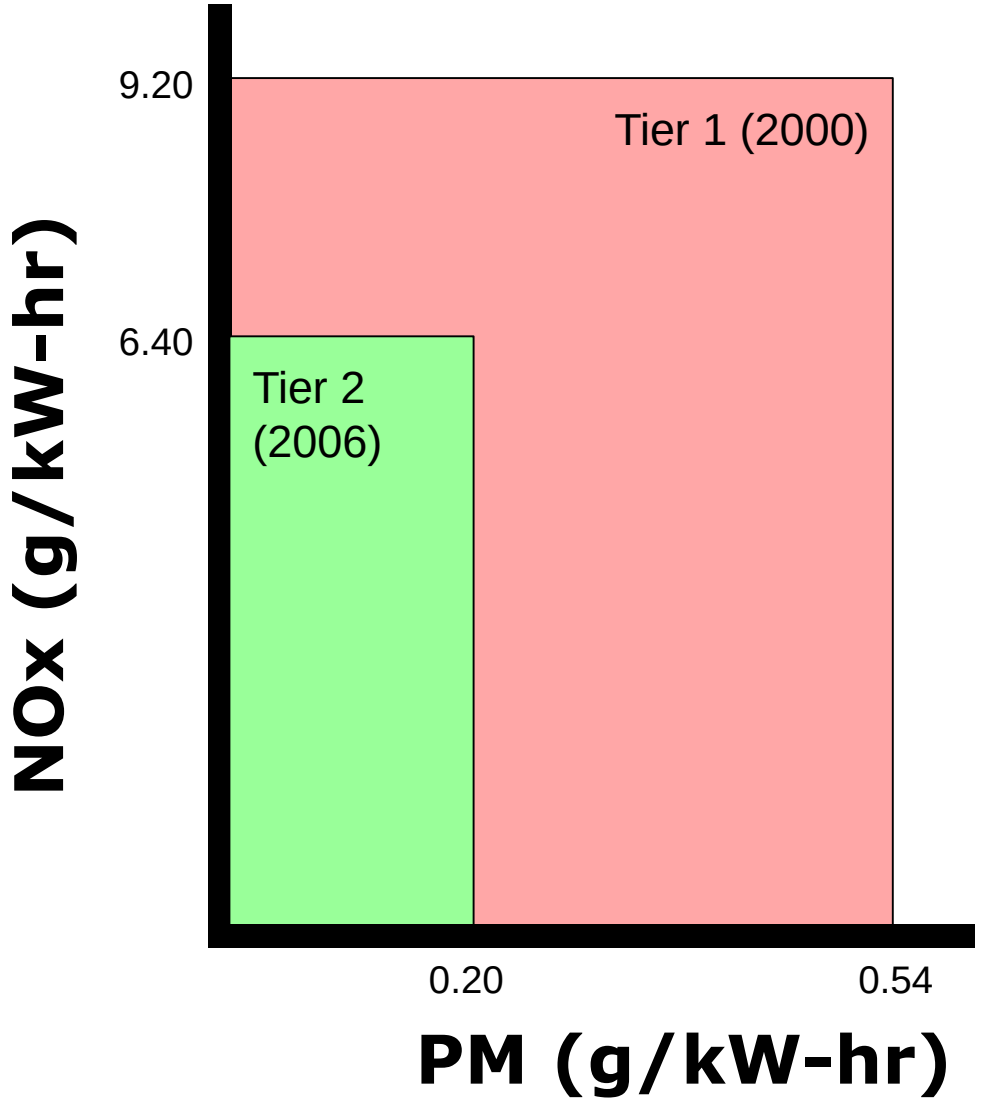

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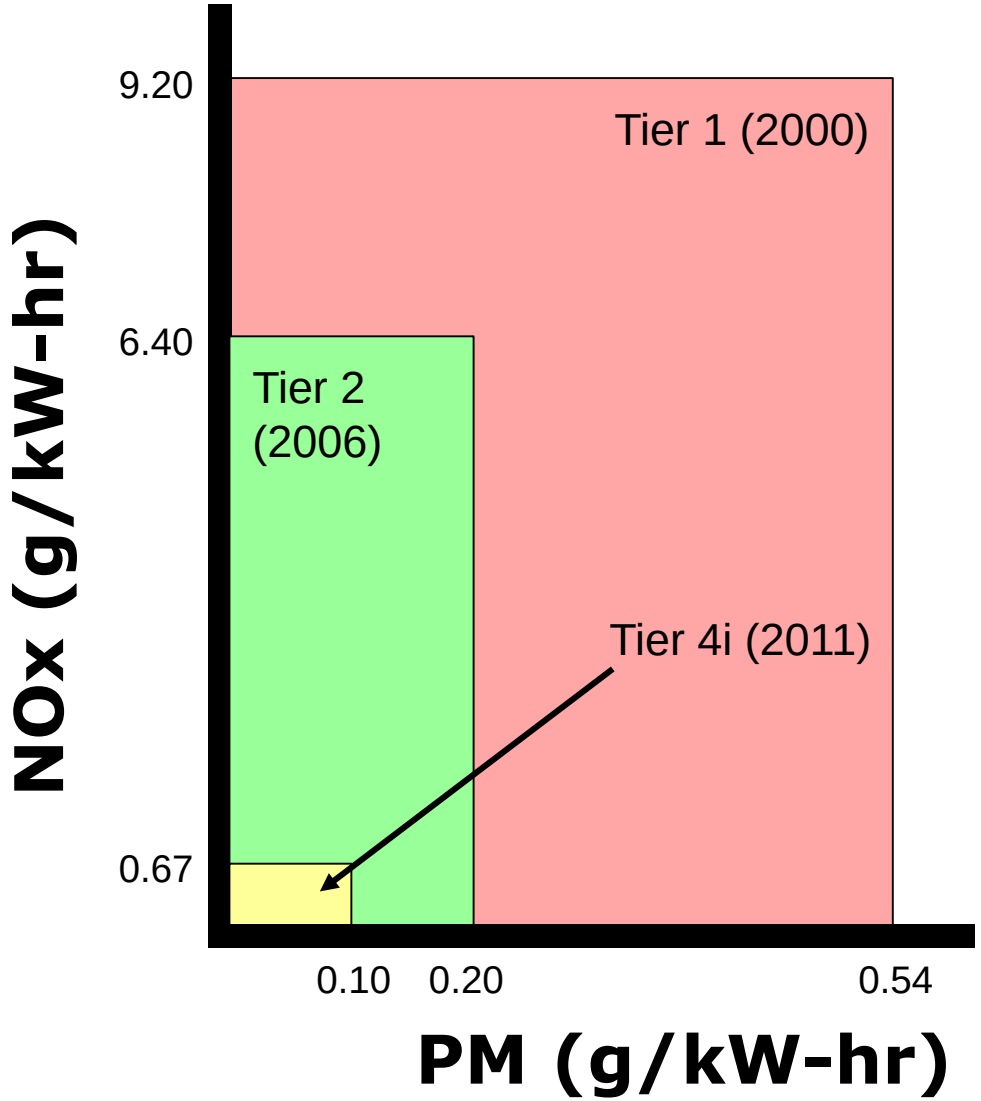

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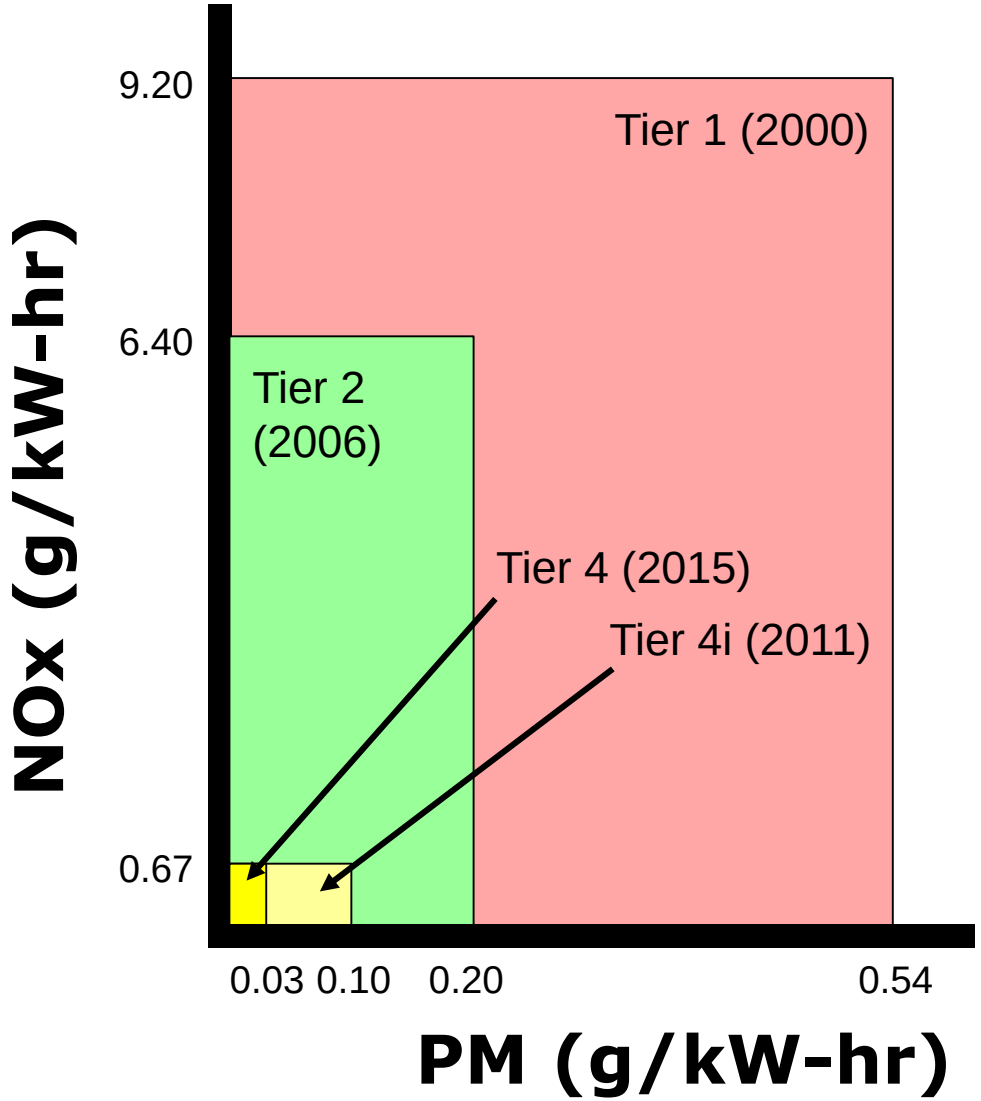

EPA NSPS for CI Engines

Regulated Emissions Levels

kW	(hp)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0-7	0-10	(7.5) / 8.0 / 0.40												
8-18	11-24	(7.5) / 6.6 / 0.40												
19-36	25-48	(7.5) / 5.5 / 0.30			(4.7) / 5.5 / 0.03 **Emergency: Stay at previous tier**									
37-55	49-74	*Optional T4i 0.30 PM*			(4.7) / 5.0 / 0.03 **Emergency: Stay at previous tier**									
56-129	75-173	Tier 3		3.4 / 0.19 / 5.0 / 0.02 **Tier 3**			0.40 / 0.19 / 5.0 / 0.02 **Tier 3**							
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		T2	T3	Tier 4 Interim			Tier 4 Final							

(a) Applies to non-emergency power gen engines > 900kW (> 1207hp).

(b) Applies to non-emergency power gen engines > 560kW (> 751hp).

Emergency engine tier levels shown in **RED**

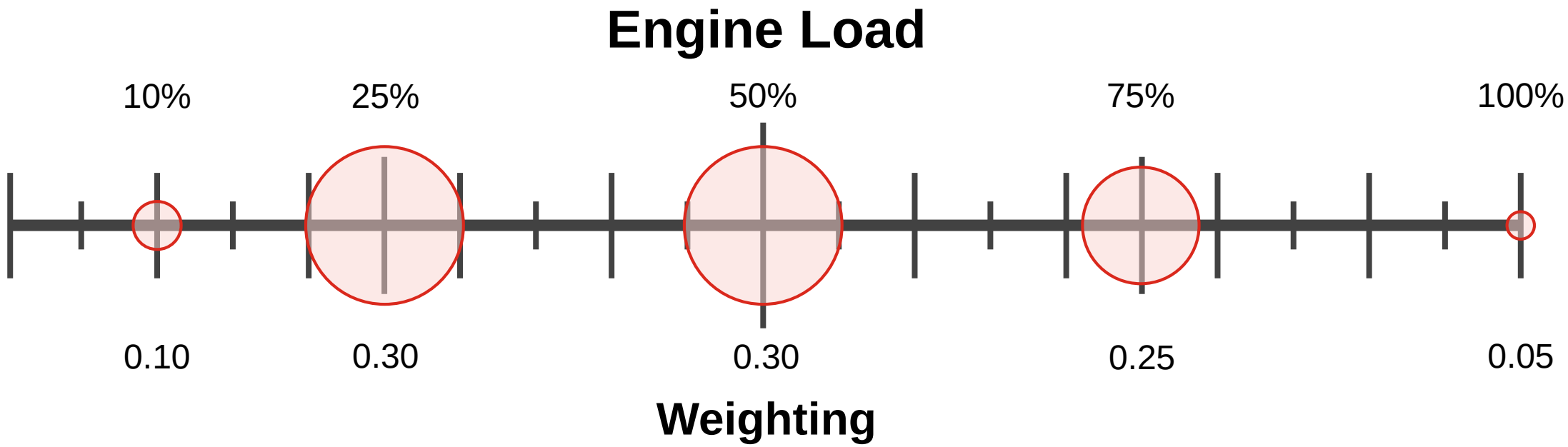
NOx / NMHC / CO / PM (g/kW-hr)

(NOx+NMHC) / CO / PM (g/kW-hr)

Certified product follows ISO 8178 D2 - 5 Mode Test Cycle for constant speed engines

EPA NSPS for CI Engines

Pollutant and Engine Load Weighting



EPA NSPS for CI Engines

Mandatory Manufacturer Certification

CI Engines including exhaust aftertreatment must be certified as a complete solution by engine manufacturer.

- Stationary Emergency (e.g. Tier 2)

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CI Engines certified Stationary Emergency may be upfit with aftertreatment provided by the engine manufacturer or third-party to meet targeted emissions levels.

- Stationary Emergency certified with third-party provided aftertreatment meeting Stationary Non-Emergency limits (e.g. Tier 4)

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CI Engine may only operate as certified by engine manufacturer (e.g. Stationary Emergency).

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Spec Note Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary non-emergency engines.

New Source Performance Standards (NSPS) for Stationary SI engines

Title 40, Part 60: Subpart JJJJ

EPA NSPS for SI Engines

Regulated Emissions Levels

Mandatory or Voluntary			HP	NOx/CO/VOC (g/bhp-hr) (NOx + HC) / CO (g/bhp-hr) 2015	2016	2017	2018	2019	2020	2021
NG / LPG: Non-emergency										
V	NG	RB	26-99	1048 or for on- site ver. use 1048.101(c) for in- field test						
			>100	1.0 / 2.0 / 0.7						
V	NG	LB	26-99	1048 or for on- site ver. use 1048.101(c) for in- field test						
			>100	1.0 / 2.0 / 0.7						
V	LPG	LB	26-99	1048 or for on- site ver. use 1048.101(c) for in- field test						
			>100	1.0 / 2.0 / 0.7						
M	LPG	RB	>25	1048 cert: (2.7)/4.4						
Natural Gas / LPG: Emergency										
V	NG & LB LPG		26-129	90.103 phase 1 class II cert: (10) / 387						
			> 130	2.0 / 4.0 / 1.0						
M	LPG RB		26-129	90.103 phase 1 class II cert: (10) / 387						
			> 130	1048 full cert: 2.0 / 4.0 / 1.0						
Landfill / Digester Gas										
V	All LB & RB		All	2.0 / 5.0 / 1.0						

Notes
1. Gasoline engine requirements are same as those for RB LPG.
2. All new engines ≤ 25 hp must be certified to Part 90 on July 1, 2008.
3. Engines ≤ 40 hp that are ≤ 1000 cc may instead comply with Part 90.
4. Emergency engines limited to 100 hours per year for maintenance and testing.
5. O/O of new non-emergancy LB SI engines ≥250hp at a major source complying with 40 CFR 63 ZZZZ Table 2a do not have to comply with CO emissions of above table

EPA NSPS for SI Engines

Regulated Emissions Levels

Mandatory or Voluntary			HP	NOx/CO/VOC (g/bhp-hr) (NOx + HC) / CO (g/bhp-hr) 2015	2016	2017	2018	2019	2020	2021
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	LPG	LB	26-99	1048 or for on- site ver. use 1048.101(c) for in- field test						
			>100	1.0 / 2.0 / 0.7						
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EPA NSPS for SI Engines

Certification Summary

- Mandatory factory certification of rich burn propane engines
- Optional factory certification of all natural gas engines and lean burn propane engines
- If not factory certified, the owner/operator must perform certain tasks:

Engine Power	Maintenance plan and records, maintain/operate engine in a way to minimize emissions	Initial performance testing within 1 year of engine startup	Subsequent performance testing every 8,760 hours or 3 years, whichever comes first
< 100 hp	✓		
100-500 hp	✓	✓	
> 500 hp	✓	✓	✓

Specifying Emissions Requirements Beyond EPA Stationary Emergency

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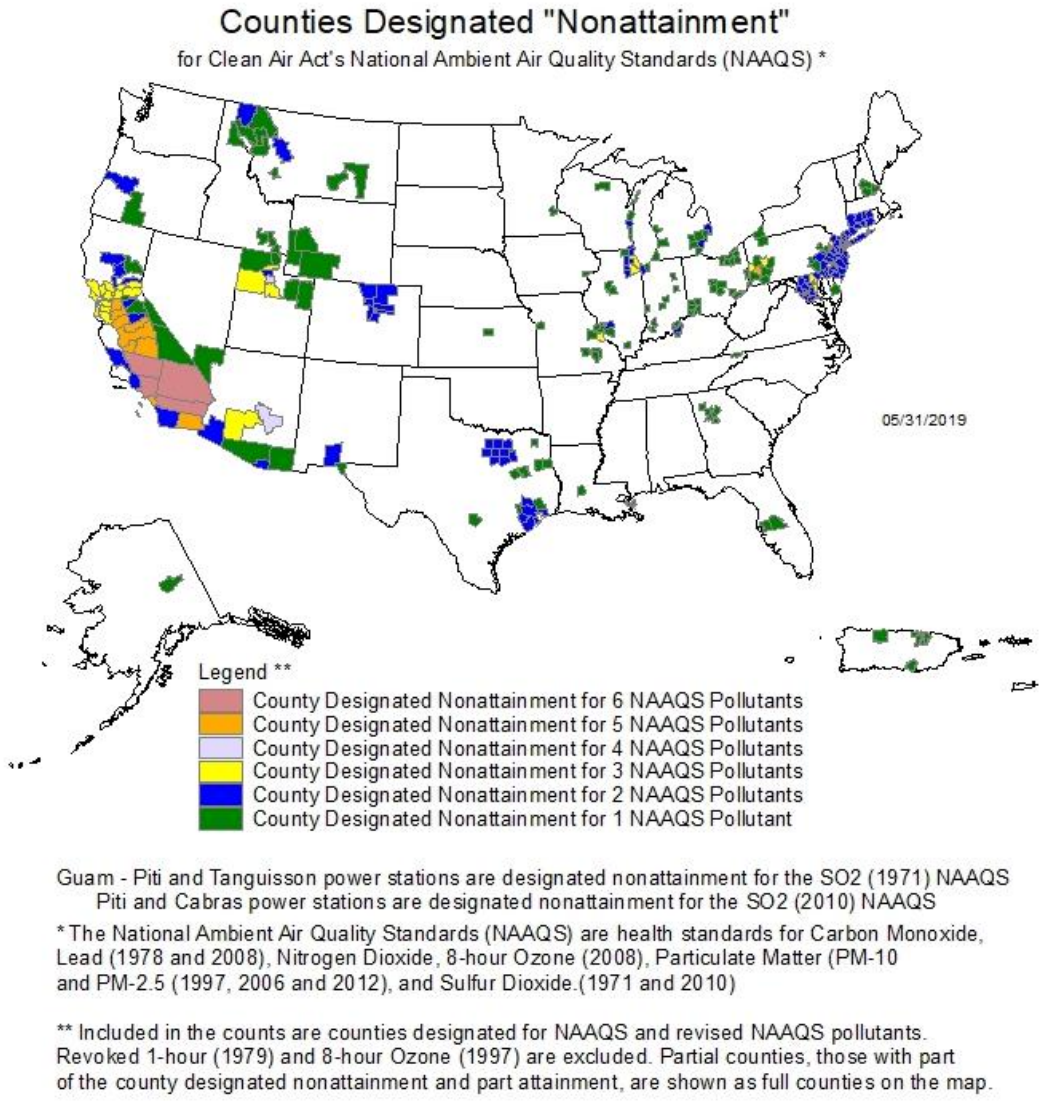
- To legally operate engines in non-emergency applications (demand response, base load, prime power, etc.).
- To achieve emissions levels exceeding EPA requirements:
  - Voluntarily reduce emissions footprint (e.g. LEED)
  - Meet local / state requirements

Spec Note Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement.

National Ambient Air Quality Standards (NAAQS)

- Identifies pollutants that are harmful to human health.
- Establishes criteria pollutant limits for geographical areas:
  - CO, Pb, NO_2, O_3, PM and SO_2



Source: https://www3.epa.gov/airquality/greenbook/mapnpoll.html

“State and local agencies are not prevented from providing additional regulations beyond these regulations and such agencies may institute additional testing requirements independent of EPA related actions.”

Response to Public Comments on Proposed Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

State / City / County Requirements

a. Emissions testing for each selected emergency engine-generator set shall consist of three one-hour test runs under load. The average of the three runs shall be reported as the short-term emission rate for that emergency engine-generator set.

b. Testing shall be conducted while operating at greater than ninety percent of the engine-generator set's standby rated capacity, unless multiple load band testing is approved by DEQ.

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Spec Note Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement and applicable test methodology.

On-Site Testing

- Non-standard equipment may be needed to secure air-permit / conduct on-site testing:
  - Fuel flow meter(s)
  - Pollutant monitor(s)
  - Exhaust sample port(s)
  - Load banks
- Test methodology and permit data must be verified by equipment manufacturer.
- Applicable environmental correction factors allowable by AHJ must be identified.
- Costs and time associated with on-site testing requirements must be considered.
- Review air permit requirements early in the project in order to accommodate lead times.
- Leverage experience of third-party testing companies and engine manufacturers.
- Review implications of failing on-site test including penalties and project delays.
- Permitted emissions values may need to be “guaranteed” by the engine manufacturer.

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Concept Check

Facility owners with stationary engines installed on-site are obligated to meet which of the following:

a) EPA guidelines for engine operation, as applicable
b) State guidelines for engine operation, as applicable
c) Local air permitting requirements, as applicable
d) All of the above

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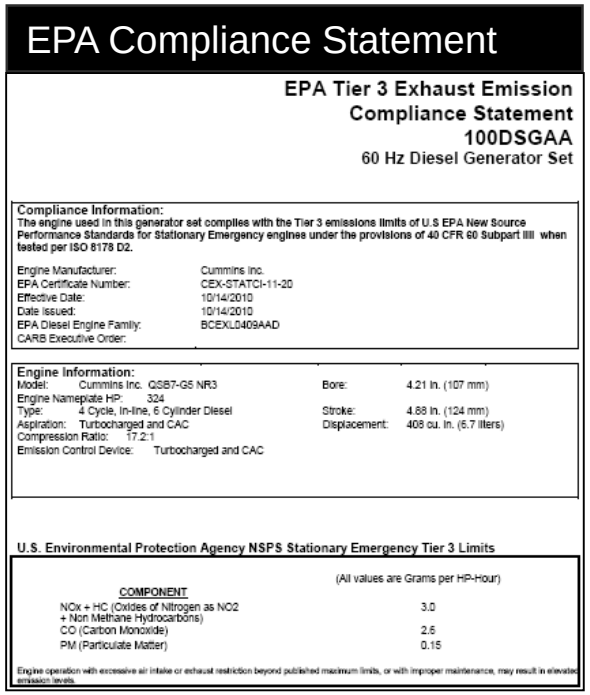
Compliance Documentation



EPA Compliance Statement

EPA Tier 3 Exhaust Emission Compliance Statement
100DSGAA
60 Hz Diesel Generator Set

Compliance Information:
The engine used in this generator set complies with the Tier 3 emissions limits of U.S EPA New Source Performance Standards for Stationary Emergency engines under the provisions of 40 CFR 60 Subpart IIII when tested per ISO 8178 D2.

Engine Manufacturer:	Cummins Inc.
EPA Certificate Number:	CEX-STATCI-11-20
Effective Date:	10/14/2010
Date Issued:	10/14/2010
EPA Diesel Engine Family:	BCEXL0409AAD
CARB Executive Order:	

Engine Information:

Model:	Cummins Inc. QSB7-G5 NR3	Bore:	4.21 in. (107 mm)
Engine Nameplate HP:	324		
Type:	4 Cycle, In-line, 6 Cylinder Diesel	Stroke:	4.88 in. (124 mm)
Aspiration:	Turbocharged and CAC	Displacement:	408 cu. in. (6.7 liters)
Compression Ratio:	17.2:1		
Emission Control Device:	Turbocharged and CAC		

U.S. Environmental Protection Agency NSPS Stationary Emergency Tier 3 Limits

(All values are Grams per HP-Hour)

COMPONENT	
NOx + HC (Oxides of Nitrogen as NO2 + Non Methane Hydrocarbons)	3.0
CO (Carbon Monoxide)	2.6
PM (Particulate Matter)	0.15

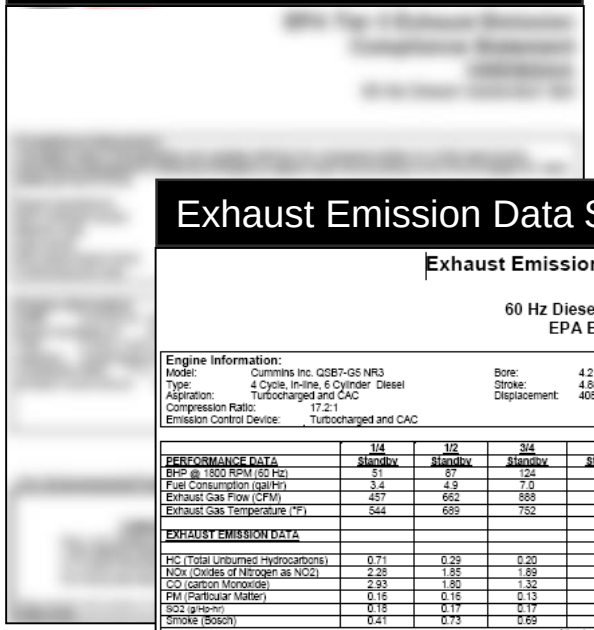
Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may result in elevated emission levels.

EPA Compliance Statement

Manufacturer statement certifying the generator set's engine compliance with EPA regulations for a specific model year

Compliance Documentation

EPA Compliance Statement



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Exhaust Emission Data Sheet

Exhaust Emission Data Sheet
100DSGAA
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EPA Emission: Tier 3

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Compression Ratio:	17.2:1		
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PERFORMANCE DATA	1/4 Standby	1/2 Standby	3/4 Standby	Full Standby	Full Prime
BHP @ 1800 RPM (60 Hz)	51	87	124	162	147
Fuel Consumption (gal/Hr)	3.4	4.9	7.0	8.7	8.1
Exhaust Gas Flow (CFM)	457	662	888	1106	1022
Exhaust Gas Temperature (°F)	544	689	752	807	788
EXHAUST EMISSION DATA					
HC (Total Unburned Hydrocarbons)	0.71	0.29	0.20	0.12	0.15
NOx (Oxides of Nitrogen as NO2)	2.28	1.85	1.69	1.54	1.52
CO (carbon Monoxide)	2.93	1.80	1.32	0.83	1.03
PM (Particular Matter)	0.16	0.16	0.13	0.10	0.11
SO2 (g/Hp-hr)	0.18	0.17	0.17	0.16	0.17
Smoke (Bosch)	0.41	0.73	0.69	0.65	0.67

All values are Grams per HP-Hour

TEST CONDITIONS

Data is representative of steady-state engine speed (± 25 RPM) at designated genset loads. Pressures, temperatures, and emission rates were stabilized.

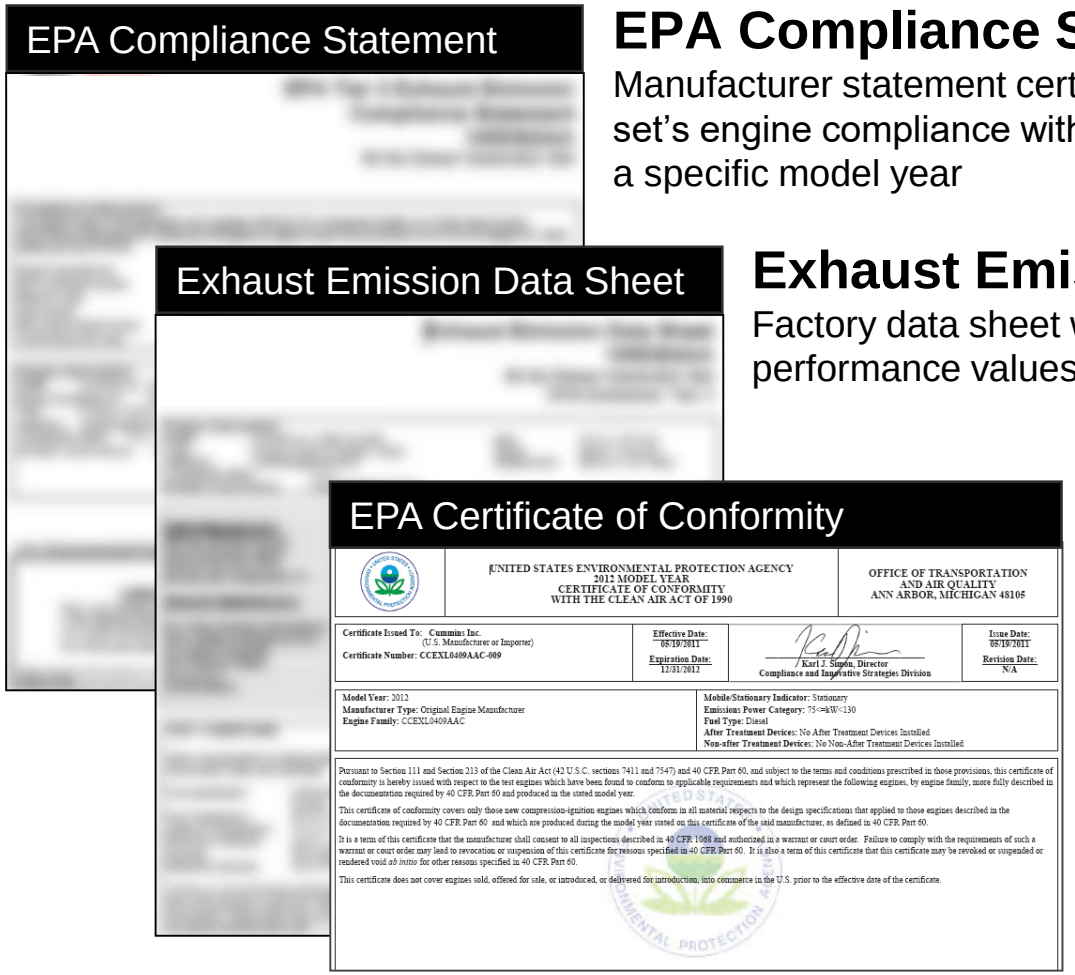
Fuel Specification:	ASTM D975 No. 2-D diesel fuel with 0.03-0.05% sulfur content (by weight), and 40-48 cetane number.
Fuel Temperature:	99 ± 9 °F (at fuel pump inlet)
Intake Air Temperature:	77 ± 9 °F
Barometric Pressure:	29.6 ± 1 in. Hg
Humidity:	NOx measurement corrected to 75 grains H2O/lb dry air
Reference Standard:	ISO 8178

The NOx, HC, CO and PM emission data tabulated here are representative of test data taken from a single engine under the test conditions shown above. Data for the other components are estimated. These data are subjected to instrumentation and engine-to-engine variability. Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures and instrumentation. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits or with improper maintenance, may results in elevated emission levels.

Exhaust Emission Data Sheet

Factory data sheet with recorded emissions and performance values at different load levels.

Compliance Documentation



EPA Compliance Statement

Manufacturer statement certifying the generator set's engine compliance with EPA regulations for a specific model year

Exhaust Emission Data Sheet

Factory data sheet with recorded emissions and performance values at different load levels.

EPA Certificate of Conformity

EPA statement certifying conformity of the engine with EPA regulations for a specific model year.

Spec Note Require generator set vendor to provide documentation of engine EPA certification including EPA Family name and generator set model.

Specification Language

1.06 APPLICABLE CODES, STANDARDS AND APPROVALS

A. The design, equipment, installation, and testing shall be in accordance with the applicable requirements set forth in the following standards:

1. NFPA 70 (National Electrical Code)
2. NFPA 110 (National Fire Protection Association Standard for Emergency and Standby Power Systems)
3. NFPA 37 (National Fire Protection Association Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines)
4. ANSI/NEMA MG-1 (National Electrical Manufacturer's Association Standard for Motors and Generators)
5. ANSI/NEMA MG-2 (National Electrical Manufacturer's Association Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators)
6. ISO 8528 (International Standards Organization Standard for Engine Generators and Generator Control Switchgear)
7. ISO 3046 (International Standards Organization Standard for Reciprocating Internal Combustion Engines Performance)
8. Applicable portions of 40 CFR Part 60 (Standards of Performance for New Stationary Sources) as indicated herein.
9. Applicable portions of 40 CFR Part 89 (Control of Emissions From New and In-Use Nonroad Compression-Ignition Engines) as indicated herein.

B. Compliance with requirements of the authority having jurisdiction (A.H.J.) shall also be included, if A.H.J. requirements affect the manufacturing of the equipment.

Course Summary

Emissions and Air Permitting Requirements for Standby Generator Sets

- Recognize commonly regulated exhaust emissions constituents.
- Describe EPA emissions requirements for diesel and gaseous standby generator sets.
- Identify common requirements for permitting engine-driven generator sets.

Specify:

- Generator set shall include engine which complies with U.S. EPA New Source Performance Standards (NSPS) for **Stationary Emergency** engines under the provisions of [40 CFR Part 60 Subpart IIII or 40 CFR Part 60 Subpart JJJJ] when tested per ISO 8178 D2.
- Engine shall meet emissions limits as defined for **Stationary Emergency** engines in [40 CFR Part 60 Subpart IIII or 40 CFR Part 60 Subpart JJJJ] when tested per ISO 8178 D2.

Avoid specifying:

- Generator set shall be Tier 2 certified.
- Engine generator set shall meet emissions requirements as determined by AHJ.

Q&A

Type your questions, comments, feedback in the **WebEx Q&A box**. We will get to as many questions as we can

We will publish consolidated FAQ along with presentation and webinar recording on powersuite.cummins.com

Your local Cummins contacts:

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- For other states and territories, email powergenchannel@cummins.com or visit http://power.cummins.com/sales-service-locator

Closing

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Please contact Mohammed Gulam if you have any questions related to the PowerHour webinar (mohammed.gulam@cummins.com)


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