

# Stationary

## Emissions-At-A-Glance

# COMPRESSOR

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## United States

Environmental Protection Agency (EPA)

### Existing Stationary Diesel Engines

NESHAP Emissions Requirements for Existing Stationary Diesel (Compression Ignition [CI]) Engines		
Engine Category	Emissions Standard	Alternative CO Reduction
<b>Area Sources</b>		
Nonemergency 300 < hp ≤ 500	49 ppm CO	70%
Nonemergency > 500 hp	23 ppm CO	70%
<b>Major Sources</b>		
Nonemergency 100 ≤ hp ≤ 300	230 ppm CO	-
Nonemergency 300 < hp ≤ 500	49 ppm CO	70%
Nonemergency > 500 hp	23 ppm CO	70%

Standards for spark ignition, gas-fired stationary engines are summarized in Table 2. The engine designations indicate two- or four-stroke (2S/4S) lean- or rich-burn (LB/RB) natural gas or landfill/digester gas (LFG/DG) engines.

NESHAP Emissions Requirements for Stationary Gas (Spark Ignition [SI]) Engines		
Engine Category	Emissions Standard	Alternative CO/HCHO Reduction
Area Sources*		
4SLB, Nonemergency > 500 hp	Install OC <sup>a</sup>	
4SRB, Nonemergency > 500 hp	Install NSCR <sup>b</sup>	
Major Sources		
2SLB, Nonemergency 100 ≤ hp ≤ 500	225 ppm CO	-
4SLB, Nonemergency 100 ≤ hp ≤ 500	47 ppm CO	-
4SRB, Non-Emergency 100 ≤ hp ≤ 500	10.3 ppm HCHO	-
LFG/DG, Nonemergency 100 ≤ hp ≤ 500	177 ppm CO	-
4SRB, Nonemergency > 500 hp	350 ppb HCHO	76% HCHO <sup>c</sup>

\*Standards applicable only to engines operated >24 hr/yr and installed in locations that are not "remote areas." Remote areas include (1) offshore locations along that portion of the coast that is in direct contact with the open seas, (2) pipeline segments with 10 or fewer buildings intended for human occupancy and no buildings with four or more stories within 220 yards on either side of the centerline of any continuous 1 mile length of pipeline, or (3) nongas pipeline locations that have five or fewer buildings intended for human occupancy and no buildings with four or more stories within a 0.25 mile radius around the engine.

<sup>a</sup> The oxidation catalyst must provide a 93% CO emissions reduction or a 47 ppm CO concentration.

<sup>b</sup> The NSCR catalyst must provide a 75% CO reduction or a 30% THC reduction or a CO concentration of 270 ppm.

<sup>c</sup> Alternative option: 30% THC reduction.

### Other Provisions: NESHAP

**Diesel Fuel:** Certain categories of diesel engines are required to use ultralow sulfur diesel (ULSD, max. 15 ppm S) fuel.

- Stationary nonemergency engines greater than 300 hp with a displacement of less than 30 liters per cylinder, fully effective from 2013.
- Stationary emergency engines ≥100 hp that operate for more than 15 hr/yr for emergency demand response, effective from 2015.

Emissions Requirements For Non-Emergency Stationary Engines			
Displacement (D)	Power	Year	Emissions Certification
D < 10 L per cylinder	≤ 3000 hp	2007+	Nonroad Tier 2/3/4
	> 3000 hp	2007 to 2010	Nonroad Tier 1
		2011+	Nonroad Tier 2/4
10 ≤ D < 30 L per cylinder	All	2007+	Marine Cat. 2 Tier 2/3/4
D ≥ 30 L per cylinder	All	2010 to 2011	Marine Cat. 3 Tier 1
		2012+	Marine Cat. 3 Tier 2/3

### Nonroad Diesel Engines

Tier 4 Emissions Standards — Engines Above 560 kW, g/kWh (g/bhp-hr)					
Year	Category	CO	NMHC	NO <sub>x</sub>	PM
2011	Gen-sets > 900 kW	3.5 (2.6)	0.40 (0.30)	0.67 (0.50)	0.10 (0.075)
	All engines except gen-sets > 900 kW	3.5 (2.6)	0.40 (0.30)	3.5 (2.6)	0.10 (0.075)
2015	Generator sets	3.5 (2.6)	0.19 (0.14)	0.67 (0.50)	0.03 (0.022)
	All engines except gen-sets	3.5 (2.6)	0.19 (0.14)	3.5 (2.6)	0.04 (0.03)

## European Union

### Stage 3/4 Standards

Stage 3 standards — which are further divided into two sub-stages: Stage 3a and Stage 3a — and Stage 4 standards for nonroad diesel engines are listed. These limit values apply to all nonroad diesel engines of indicated power range for use in applications other than propulsion of locomotives, railcars and inland waterway vessels, which are listed in their own tables. (See [www.dieselnet.com](http://www.dieselnet.com) for more details and inland waterway vessel data.)

The implementation dates in the following tables refer to the market placement dates. For all engine categories, a sell-off period of two years is allowed for engines produced prior to the respective market placement date. The dates for new type approvals are, with some exceptions, one year ahead of the respective market placement date.

Stage 3a Standards For Nonroad Engines						
Cat.	Net Power kW	Date <sup>†</sup>	CO g/kWh	NO <sub>x</sub> +HC	PM	
H	130 ≤ P ≤ 560	2006.01	Jan. 2006	3.5	4.0	0.2
I	75 ≤ P < 130	Jan. 2007	5.0	4.0	0.3	
J	37 ≤ P < 75	Jan. 2008	5.0	4.7	0.4	
K	19 ≤ P < 37	Jan. 2007	5.5	7.5	0.6	

<sup>†</sup> Dates for constant speed engines are: 2011.01 for categories H, I and K; Jan. 2012 for category J.



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Stage 3b Standards For Rail Traction Engines							
Cat.	Net Power kW	Date	CO g/kWh	HC	HC+NO <sub>x</sub>	NO <sub>x</sub>	PM
RC B	130 < P	Jan. 2012	3.5	0.19	-	2.0	0.025
R B	130 < P	Jan. 2012	3.5	-	4.0	-	0.025

Stage 3b Standards For Nonroad Engines						
Cat.	Net Power kW	Date	CO g/kWh	HC	NO <sub>x</sub>	PM
L	130 ≤ P ≤ 560	Jan. 2011	3.5	0.19	2.0	0.025
M	75 ≤ P < 130	Jan. 2012	5.0	0.19	3.3	0.025
N	56 ≤ P < 75	Jan. 2012	5.0	0.19	3.3	0.025
P	37 ≤ P < 56	Jan. 2013	5.0	4.7 <sup>†</sup>		0.025

<sup>†</sup> NO<sub>x</sub>+HC

Stage 4 Standards For Nonroad Engines						
Cat.	Net Power kW	Date	CO g/kWh	HC	NO <sub>x</sub>	PM
Q	130 ≤ P ≤ 560	Jan. 2014	3.5	0.19	0.4	0.025
R	56 ≤ P < 130	Oct. 2014	5.0	0.19	0.4	0.025

## Stage 5 Standards

Stage 5 emission limits for engines in nonroad mobile machinery (category NRE) are shown below. These standards are applicable to diesel (CI) engines from 0 to 56 kW and to all types of engines above 56 kW. Engines above 560 kW used in generator sets (category NRG) must meet standards shown in Category NRG-v/c-1<sup>a</sup>.

Stage 5 Emissions Standards For Nonroad Engines							
Category	Net Power kW	Date	CO	HC g/kWh	NO <sub>x</sub>	PM	PN 1/kWh
NRG-v/c-1 <sup>a</sup>	P > 560	Jan. 2019	3.50	0.19 <sup>b</sup>	0.67	0.035	-
NRE-v/c-7	P > 560	Jan. 2019	3.50	0.19 <sup>b</sup>	3.50	0.045	-
NRE-v/c-6	130 ≤ P ≤ 560	Jan. 2019	3.50	0.19 <sup>c</sup>	0.40	0.015	1×10 <sup>12</sup>
NRE-v/c-5	56 ≤ P < 130	Jan. 2020	5.00	0.19 <sup>c</sup>	0.40	0.015	1×10 <sup>12</sup>
NRE-v/c-4	37 ≤ P < 56	Jan. 2019	5.00	4.70 <sup>c,d</sup>		0.015	1×10 <sup>12</sup>
NRE-v/c-3	19 ≤ P < 37	Jan. 2019	5.00	4.70 <sup>c,d</sup>		0.015	1×10 <sup>12</sup>

Stage 5 Emissions Standards For Nonroad Engines (continued)						
NRE-v/c-2	8 ≤ P < 19	Jan. 2019	6.60	7.50 <sup>c,d</sup>	0.40	-
NRE-v/c-1	P < 8	Jan. 2019	8.00	7.50 <sup>c,d</sup>	0.40 <sup>e</sup>	-

<sup>a</sup> Generator sets above 560 kW

<sup>b</sup> A = 6.00 for gas engines

<sup>c</sup> A = 1.10 for gas engines

<sup>d</sup> HC+NO<sub>x</sub>

<sup>e</sup> 0.60 for hand-startable, air-cooled direct injection engines

## Gothenburg Protocol — Stationary Engine Guidelines

NO<sub>x</sub> emissions limits for new stationary engines specified by the Gothenburg Protocol are listed.

(applicable to all parties other than Canada and the USA)

NO <sub>x</sub> Emissions Limits From New Stationary Engines	
Description	NO <sub>x</sub> Limit, mg/Nm <sup>3</sup>
<b>Spark ignition (Otto) engines, 4-stroke, &gt;1 MW</b>	
Lean-burn engines	250
All other engines	500
<b>Compression ignition (Diesel) engines, &gt;5 MW</b>	
Fuel: natural gas (jet ignition engines)	500
Fuel: heavy fuel oil	600
Fuel: diesel oil or gas oil	500

NO<sub>x</sub> is specified as NO<sub>2</sub> equivalent. Concentrations are expressed at standard temperature and pressure conditions (273.15 K, 101.3 kPa) and at an oxygen reference content of 5%. The limits do not apply to engines running less than 500 hr/yr. Startup, shutdown and maintenance of equipment are also excluded. Meeting the limits by lowering exhaust concentrations through dilution is not permitted. The Protocol also specifies emissions monitoring and reporting requirements.

## World Bank Guidelines — Stationary Engines

The maximum emissions levels are expressed as concentrations, to facilitate monitoring. The emissions limits are to be achieved through a variety of control and fuel technologies, as well as through good maintenance practice. Dilution of air emissions to achieve the limits is not acceptable. The following are emissions limits for engine-driven power plants:

**Particulate matter.** PM emissions (all sizes) should not exceed 50 mg/Nm<sup>3</sup>.

**Sulfur dioxide.** Total SO<sub>2</sub> emissions should be less than 0.20 metric tons per day (tpd) per MWe of capacity for the first 500 MWe, plus 0.10 tpd for each additional MWe of capacity over 500 MWe. In addition, the SO<sub>2</sub> concentration in flue gases should not exceed 2000 mg/Nm<sup>3</sup>, with a maximum emissions level of 500 tpd.

**Nitrogen oxides.** Provided that the resultant maximum ambient levels of nitrogen dioxide are less than 150 µg/m<sup>3</sup> (24-hour average), the NO<sub>x</sub> emissions levels should be less than 2000 mg/Nm<sup>3</sup> (or 13 g/kWh, dry at 15% O<sub>2</sub>). In all other cases, the maximum NO<sub>x</sub> emissions level is 400 mg/Nm<sup>3</sup> (dry at 15% O<sub>2</sub>).



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