

COMPRESSOR

TECH²

DEDICATED TO GLOBAL GAS COMPRESSION PRODUCTS AND APPLICATIONS

2021

STATIONARY EMISSIONS AT-A-GLANCE

SPONSORED BY:

Waukesha
INNO

2021 Stationary Emissions At-A-Glance

UNITED STATES

Environmental Protection Agency (EPA)

Existing stationary diesel engines

TABLE 1
NESHAP EMISSION REQUIREMENTS FOR EXISTING STATIONARY CI ENGINES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO REDUCTION
Area Sources		
Non-Emergency 300 < hp ≤ 500	49 ppm CO	70%
Non-Emergency > 500 hp	23 ppm CO	70%
Major Sources		
Non-Emergency 100 ≤ hp ≤ 300	230 ppm CO	-
Non-Emergency 300 < hp ≤ 500	49 ppm CO	70%
Non-Emergency > 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.

TABLE 2
NESHAP EMISSION REQUIREMENTS FOR EXISTING STATIONARY SI ENGINES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO/HCHO REDUCTION
Area Sources[†]		
4SLB, Non-Emergency > 500 hp	Install OC ^a	
4SRB, Non-Emergency > 500 hp	Install NSCR ^b	
Major Sources		
2SLB, Non-Emergency 100 ≤ hp ≤ 500	225 ppm CO	-
4SLB, Non-Emergency 100 ≤ hp ≤ 500	47 ppm CO	-
4SRB, Non-Emergency 100 ≤ hp ≤ 500	10.3 ppm HCHO	-
LFG/DG, Non-Emergency 100 ≤ hp ≤ 500	177 ppm CO	-
4SRB, Non-Emergency > 500 hp	350 ppb HCHO	76% HCHO ^c

[†] 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 660 ft. (220 yards) on either side of the centerline of any continuous 1 mile (1.6 km) length of pipeline, or (3) non gas-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 (0.4 km) radius around the engine.

^a The oxidation catalyst must provide a 93% CO emission reduction or a 47 ppm CO concentration.

^b The NSCR catalyst must provide a 75% CO reduction or a 30% THC reduction or a CO concentration of 270 ppm.

^c Alternative option: 30% THC reduction.

NEW ENGINES. NESHAP standards are also applicable to certain categories of new CI and SI engines located at major sources, Table 3. Note that "new" engine does not mean newly built engine – see the definitions above.

TABLE 3
NESHAP EMISSION REQUIREMENTS FOR NEW CI AND SI ENGINES AT MAJOR SOURCES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO/HCHO REDUCTION
CI Engines		
Non-Emergency > 500 hp	580 ppb CH ₂ O	70% CO
SI Engines		
2SLB, Non-Emergency > 500 hp	12 ppm CH ₂ O	58% CO
4SLB, Non-Emergency > 250 hp	14 ppm CH ₂ O	93% CO
4SRB, Non-Emergency > 500 hp	350 ppb CH ₂ O	76% CH ₂ O

Note: New limited use engines > 500 hp at major sources do not meet any emission standards under the NESHAP.

New and reconstructed engines of lower horsepower (< 500 hp; 4SLB < 250 hp) located at major sources, as well as new engines located at area sources must meet the applicable NSPS CI or NSPS SI emission standards.

EMISSION REQUIREMENTS FOR NON-EMERGENCY STATIONARY ENGINES

DISPLACEMENT (D)	POWER	YEAR	EMISSION CERTIFICATION
D < 10 L per cylinder	≤ 3000 hp	2007+	Nonroad Tier 2/3/4
		2007-2010	Nonroad Tier 1
	> 3000 hp	2011+	Nonroad Tier 2/4
10 ≤ D < 30 L per cylinder	All	2007+	Marine Cat. 2 Tier 3/4/3/4
D ≥ 30 L per cylinder	All	2010-2011	Marine Cat. 3 Tier 1
		2012+	Marine Cat. 3 Tier 2/3

Nonroad diesel engines

TABLE 4
TIER 4 EMISSION STANDARDS—ENGINES ABOVE 560 KW, G/KWH (G/BHP-HR)

YEAR	CATEGORY	CO	NMHC	NO _x	PM
2011	Generator sets > 900 kW	3.5 (2.6)	0.40 (0.30)	0.67 (0.50)	0.10 (0.075)
	All engines except gensets > 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 gensets	3.5 (2.6)	0.19 (0.14)	3.5 (2.6)	0.04 (0.03)

Other provisions

CRANKCASE FILTRATION. Stationary engines – including CI ≥ 100 hp (74.6 kW) at major source, CI > 300 hp (223.7 kW) at area source, and SI 100 to 500 hp (74.6 to 372.8 kW) at major source – must be equipped with closed or open crankcase filtration system in order to reduce metallic HAP emissions.

CANADA

The first Canadian federal emission standards for stationary compression-ignition (SCI) engines were adopted in December 2020. The SCI emission requirements are applicable to engines that have a displacement of less than 30 L per cylinder and are used to provide primary sources of electricity or power machines such as fire pumps and emergency backup generators. The new SCI emission standards took effect June 4, 2021 and are based on the date of manufacture.

APPLICABLE US EPA TIERS FOR CANADIAN STATIONARY COMPRESSION ENGINES

POWER RANGE	NON-BACKUP AND NON-REMOTE	BACKUP/EMERGENCY OR REMOTE
≤37 kW	Tier 4	Tier 2
>37 kW to ≤560 kW	Tier 4	Tier 3
>560 kW	Tier 4	Tier 2

Note: Fire pumps have separate, less stringent standards.

EUROPEAN UNION Stage 3/4 Standards

Stage 3 standards – which are further divided into two sub-stages: Stage 3 A and Stage 3 B – and Stage 4 standards for nonroad diesel engines are listed below. These limit values apply to all nonroad diesel engines of indicated power range for use in applications other than rail traction and inland waterway vessels. (See 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 3 A/B EMISSION STANDARDS FOR NONROAD DIESEL ENGINES

CAT.	NET POWER kW	DATE ¹	CO g/kWh	HC	HC+NOX	NO _x	PM
Stage 3 A							
H	130 ≤ P ≤ 560	2006.01	3.5	-	4.0	-	0.2
I	75 ≤ P < 130	2007.01	5.0	-	4.0	-	0.3
J	37 ≤ P < 75	2008.01	5.0	-	4.7	-	0.4
K	19 ≤ P < 37	2007.01	5.5	-	7.5	-	0.6
Stage 3 B							
L	130 ≤ P ≤ 560	2011.01	3.5	0.19	-	2.0	0.025
M	75 ≤ P < 130	2012.01	5.0	0.19	-	3.3	0.025
N	56 ≤ P < 75	2012.01	5.0	0.19	-	3.3	0.025
P	37 ≤ P < 56	2013.01	5.0	-	4.7	-	0.025

¹ Dates for constant speed engines are: 2011.01 for categories H, I and K; 2012.01 for category J.

STAGE 4 EMISSION STANDARDS FOR NONROAD DIESEL ENGINES

CAT.	NET POWER kW	DATE	CO g/kWh	HC	NO _x	PM
Q	130 ≤ P ≤ 560	2014.01	3.5	0.19	0.4	0.025
R	56 ≤ P < 130	2014.10	5.0	0.19	0.4	0.025

STAGE 3 B EMISSION STANDARDS FOR RAIL TRACTION ENGINES

CAT.	NET POWER kW	DATE	CO g/kWh	HC	HC+NOX	NO _x	PM
Stage 3 B							
RC B	P > 130	2012	3.5	0.19	-	2.0	0.025
R B	P > 130	2012	3.5	-	4.0	-	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^a.

STAGE 5 EMISSION STANDARDS FOR NONROAD ENGINES

CATEGORY	IGN.	NET POWER kW	DATE	CO	HC g/kWh	NO _x	PM	PN 1/kWh
NRE-v/c-1	CI	P < 8	2019	8.00	7.50 ^{a,c}	0.40 ^b	-	-
NRE-v/c-2	CI	8 ≤ P < 19	2019	6.60	7.50 ^{a,c}	0.40	-	-
NRE-v/c-3	CI	19 ≤ P < 37	2019	5.00	4.70 ^{a,c}	0.015	1×10 ⁻¹²	-
NRE-v/c-4	CI	37 ≤ P < 56	2019	5.00	4.70 ^{a,c}	0.015	1×10 ⁻¹²	-
NRE-v/c-5	All	56 ≤ P < 130	2020	5.00	0.19 ^a	0.40	0.015	1×10 ⁻¹²
NRE-v/c-6	All	130 ≤ P ≤ 560	2019	3.50	0.19 ^a	0.40	0.015	1×10 ⁻¹²
NRE-v/c-7	All	P > 560	2019	3.50	0.19 ^a	3.50	0.045	-

^a HC+NO_x ^b 0.60 for hand-startable, air-cooled direct injection engines

^c A = 1.10 for gas engines ^d A = 6.00 for gas engines

GOTHENBURG PROTOCOL Stationary engine guidelines

NO_x emissions limits for new stationary engines specified by the Gothenburg Protocol are listed. (applicable to all parties other than Canada and the United States).

NO_x EMISSION LIMITS FROM NEW STATIONARY ENGINES

DESCRIPTION	NO _x LIMIT, MG/NM ³
Spark ignition (Otto) engines, 4-stroke, >1 MW	
Lean-burn engines	250
All other engines	500
Compression ignition (Diesel) engines, >5 MW	
Fuel: natural gas (jet ignition engines)	500
Fuel: heavy fuel oil	600
Fuel: diesel oil or gas oil	500

NO_x is specified as NO₂ 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 emission monitoring and reporting requirements.

WORLD BANK GUIDELINES Stationary engines

The maximum emission levels are expressed as concentrations, to facilitate monitoring. The emission 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 emission limits for engine driven power plants:

PARTICULATE MATTER PM emissions (all sizes) should not exceed 50 mg/Nm³.

SULFUR DIOXIDE Total SO₂ 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 SO₂ concentration in flue gases should not exceed 2,000 mg/Nm³, 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/m³ (24-hour average), the NO_x emissions levels should be less than 2,000 mg/Nm³ (or 13 g/kWh, dry at 15% O₂). In all other cases, the maximum NO_x emission level is 400 mg/Nm³ (dry at 15% O₂).

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