

Federal Marine Compression-Ignition (CI) Engines: Exhaust Emission Standards

Category ^{a, b}	Tier	Displacement (L/cylinder)	Power ^c (kW)	Speed (rpm)	Model Year	NOx (g/kW-hr)	HC (g/kW-hr)	HC+NOx ^d (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)	Useful Life ^e (years/hours)		Warranty Period ^f (years/hours)		
C1 Commercial	1	≥ 2.5	≥ 37	rpm < 130	2004 ^h	17.0	-	-	-	-	10 / 10,000	5 / 5,000			
				130 ≤ rpm < 2000		45.0 x N ^{-0.20} ⁱ	-	-	-	-					
				rpm ≥ 2000		9.8	-	-	-	-					
	2	all	disp < 0.9	≥ 37	-	2005 ^h	-	-	7.5 (ABT)	0.40 (ABT)	5.0	10 / 10,000	5 / 5,000		
			0.9 ≤ disp < 1.2	-	2004 ^h	-	-	7.2 (ABT)	0.30 (ABT)	5.0					
1.2 ≤ disp < 2.5			-	2004 ^h	-	-	7.2 (ABT)	0.20 (ABT)	5.0						
2.5 ≤ disp < 5.0			-	2007 ^h	-	-	7.2 (ABT)	0.20 (ABT)	5.0						
C1 Commercial & Recreational	1	≥ 2.5	≥ 37	rpm < 130	2004	17	-	-	-	-	10 / 1,000	5 / 500			
				130 ≤ rpm < 2000		45.0 x N ^{-0.20} ⁱ	-	-	-	-					
				rpm ≥ 2000		9.8	-	-	-	-					
	2	all	disp < 0.9	≥ 37	-	2007	-	-	7.5 (ABT)	0.40 (ABT)	5.0	10 / 1,000	5 / 500		
			0.9 ≤ disp < 1.2	-	2006	-	-	7.2 (ABT)	0.30 (ABT)	5.0					
1.2 ≤ disp < 2.5			-	2006	-	-	7.2 (ABT)	0.20 (ABT)	5.0						
2.5 ≤ disp < 5.0			-	2009	-	-	7.2 (ABT)	0.20 (ABT)	5.0						
C1 Commercial & Recreational < 75 kW	3	< 0.9	< 8	-	2009+	-	-	7.5 (ABT)	0.40 (ABT)	8.0	5 / 3,000	10 / 1,000 for CI Recreational	2.5 / 1,500	10 / 500 for CI Recreational	
			8 ≤ kW < 19	-	2009+	-	-	7.5 (ABT)	0.40 (ABT)	6.6					
			19 ≤ kW < 37	-	2009-2013	-	-	7.5 ^j (ABT)	0.30 ^j (ABT)	5.5	7 / 5,000				
				-	2014+	-	-	4.7 ^j (ABT)	0.20 (ABT)	5.0					
			37 ≤ kW < 75	-	2009-2013	-	-	7.5 ^j (ABT)	0.30 ^j (ABT)	5.0	10 / 10,000				
				-	2014+	-	-	4.7 ^j (ABT)		5.0					

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C1 Commercial Engines with ≤ 35 kW/L power density ^k	3 ^l	< 0.9	-	-	2012+	-	-	5.4 (ABT)	0.14 (ABT)	8.0 for < 8 kW 6.6 for 8 ≤ kW < 19 5.5 for 19 ≤ kW < 37 5.0 for ≤ 37 kW	5 / 3,000 for commercial engines < 19 kW 7 / 5,000 for commercial engines 19 ≤ kW < 37 10 / 10,000 for C1 Commercial ≤ 37 kW	2.5 / 1,500 for commercial engines < 19 kW 3.5 / 2,500 for commercial engines 19 ≤ kW < 37 5 / 5,000 for C1 Commercial ≤ 37 kW
		0.9 ≤ disp < 1.2	All	-	2013+	-	-	5.4 (ABT)	0.12 (ABT)			
		1.2 ≤ disp < 2.5	< 600	-	2014-2017	-	-	5.6 (ABT)	0.11 (ABT)			
				-	2018+	-	-	5.6 (ABT)	0.10 (ABT)			
		2.5 ≤ disp < 3.5	< 600	-	2013-2017	-	-	5.6 (ABT)	0.11 (ABT)			
				-	2018+	-	-	5.6 (ABT)	0.10 (ABT)			
				≥ 600	2013+	-	-	5.6 (ABT)	0.11 (ABT)			
		3.5 ≤ disp < 7.0	< 600	-	2012-2017	-	-	5.8 (ABT)	0.11 (ABT)			
				-	2018+	-	-	5.8 (ABT)	0.10 (ABT)			
				≥ 600	2012+	-	-	5.8 (ABT)	0.11 (ABT)			
C1 Commercial Engines with > 35 kW/L power density & All Recreational Engines ^k	3 ^l	< 0.9	≥ 75	-	2012+	-	-	5.8 (ABT)	0.15 (ABT)	8.0 for < 8 kW 6.6 for 8 ≤ kW < 19 5.5 for 19 ≤ kW < 37 5.0 for ≥ 37 kW	5 / 3,000 for commercial engines < 19 kW 7 / 5,000 for commercial engines 19 ≤ kW < 37 10 / 10,000 for C1 Commercial ≥ 37 kW 10 / 1,000 for CI Recreational	2.5 / 1,500 for commercial engines < 19 kW 3.5 / 2,500 for commercial engines 19 ≤ kW < 37 5 / 5,000 for C1 Commercial ≥ 37 kW 5 / 500 for CI Recreational
		0.9 ≤ disp < 1.2	All	-	2013+	-	-	5.8 (ABT)	0.14 (ABT)			
		1.2 ≤ disp < 2.5		-	2014+	-	-	5.8 (ABT)	0.14 (ABT)			
		2.5 ≤ disp < 3.5		-	2013+	-	-	5.8 (ABT)	0.12 (ABT)			
		3.5 ≤ disp < 7.0		-	2012+	-	-	5.8 (ABT)	0.11 (ABT)			
C1 Commercial > 600 kW	4 ^m	All	600 ≤ kW < 1,400	-	2017+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)	5.0	10 / 10,000	5 / 5,000
		All	1,400 ≤ kW < 2,000	-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)			
		All	2,000 ≤ kW < 3,700	-	2014+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)			
		< 7.0	≥ 3,700	-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.12 (ABT)			
				-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.06 (ABT)			

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Category ^{a, b}	Tier	Displacement (L/cylinder)	Power ^c (kW)	Speed (rpm)	Model Year	NOx (g/kW -hr)	HC (g/kW -hr)	HC+NOx ^d (g/kW-hr)	PM (g/kW-hr)	CO (g/kW -hr)	Useful Life ^e (years/hours)	Waranty Period ^f (years/hours)
C2	1	≥ 2.5	≥ 37	rpm < 130	2004	17.0	-	-	-	-	10 / 20,000	5 / 10,000
				130 ≤ rpm < 2,000		45.0 x N ^{-0.20 i}	-	-	-			
				rpm ≥ 2,000		9.8	-	-	-			
	2	5.0 ≤ disp < 15.0	all	-	2007	-	-	7.8 (ABT)	0.27 (ABT)	5.0	10 / 20,000	5 / 10,000
			15.0 ≤ disp < 20.0	< 3,300		-	-	8.7 (ABT)	0.50 (ABT)	5.0		
			15.0 ≤ disp < 20.0	≥ 3,300		-	-	9.8 (ABT)	0.50 (ABT)	5.0		
			20.0 ≤ disp < 25.0	all		-	-	9.8 (ABT)	0.50 (ABT)	5.0		
			25.0 ≤ disp < 30.0	all		-	-	11.0 (ABT)	0.50 (ABT)	5.0		
	3 ^{o, p}	7.0 ≤ disp < 15.0	< 2,000	-	2013+	-	-	6.2 (ABT)	0.14 (ABT)	5.0	10 / 20,000	5 / 10,000
			2,000 ≤ kW < 3,700	-		-	-	7.8 (ABT)	0.14 (ABT)	5.0		
		15.0 ≤ disp < 20.0	< 2,000	-	2014+	-	-	7.0 (ABT)	0.34 (ABT)	5.0		
		20.0 ≤ disp < 25.0	< 2,000	-		-	9.8 (ABT)	0.27 (ABT)	5.0			
		25.0 ≤ disp < 30.0	< 2,000	-		-	11.0 (ABT)	0.27 (ABT)	5.0			
	4 ^{m, p}	All	600 ≤ kW < 1,400	-	2017+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)	5.0	10 / 20,000	5 / 10,000
		All	1400 ≤ kW < 2,000	-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)			
		All	2,000 ≤ kW < 3,700 ^q	-	2014+	1.8 (ABT)	-	0.19 HC ⁿ	0.04 (ABT)			
		< 15.0	≥ 3,700	-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.12 (ABT)			
		15.0 ≤ disp < 30.0		-	2014-2015	1.8 (ABT)	-	0.19 HC ⁿ	0.25 (ABT)			
		All		-	2016+	1.8 (ABT)	-	0.19 HC ⁿ	0.06 (ABT)			

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Category ^{a, b}	Tier	Displacement (L/cylinder)	Power ^c (kW)	Speed (rpm)	Model Year	NOx (g/kW -hr)	HC (g/kW -hr)	HC+NOx ^d (g/kW-hr)	PM (g/kW-hr)	CO (g/kW -hr)	Useful Life ^e (years/hours)	Waranty Period ^f (years/hours)
C3	1	≥30.0	All	rpm < 130	2004	17.0	-	-	-	-	3 / 10,000	3 / 10,000
				130 ≤ rpm < 2,000		$45.0 \times N^{-0.20 i}$	-	-	-			
				rpm ≥ 2,000		9.8	-	-	-			
	2	≥30.0	All	rpm < 130	2011	14.4	2.0	-	-	5.0	3 / 10,000	3 / 10,000
				130 ≤ rpm < 2,000		$44.0 \times N^{-0.23 i}$		-	-			
				rpm ≥ 2,000		7.7		-	-			
	3	≥ 30.0	All	rpm < 130	2016	3.4	2.0	-	-	5.0	3 / 10,000	3 / 10,000
				130 ≤ rpm < 2,000		$9.0 \times N^{-0.20 i}$		-	-			
				rpm ≥ 2,000		2.0		-	-			

Notes:

- a** For Tiers 1 and 2, Category 1 (C1) marine engines are greater than or equal to 37 kilowatts (kW) and have a displacement less than 5.0 liters per cylinder (L/cylinder); Category 2 (C2) marine engines have a displacement greater than or equal to 5.0 L/cylinder and less than 30 L/cylinder; and Category 3 (C3) marine engines have a displacement greater than or equal to 30.0 L/cylinder. For Tiers 3 and 4, Category 1 represents engines up to 7 L/cylinder displacement; and Category 2 includes engines from 7 to 30 L/cylinder. The definition of Category 3 marine engines remains the same.
- b** Tiers 1 and 2 for marine engines less than 37 kW are subject to the same emission standards as for land-based engines. See Table 1 in 40 Code of Federal Regulations (CFR) Part 89.112 and 40 CFR Part 89.104.
- c** For Tiers 1 and 2, this refers to the rated power; for Tiers 3 and 4, this refers to the maximum engine power.
- d** Total hydrocarbon (THC) plus nitrogen oxides (NOx) for Tier 2 standards.
- e** Useful life is expressed in hours or years, whichever comes first. For Tiers 3 and 4, a longer useful life in hours for an engine family must be specified if either: 1) the engine is designed, advertised, or marketed to operate longer than the minimum useful life; or 2) the basic mechanical warranty is longer than the minimum useful life.
- f** Warranty period is expressed in years and hours, whichever comes first.
- g** For Tiers 3 and 4, there are no evaporative emission standards for diesel-fueled engines, or engines using other nonvolatile or nonliquid fuels (e.g., natural gas). If an engine uses a volatile liquid fuel, such as methanol, the engine's fuel system and the vessel in which the engine is installed must meet the evaporative emission requirements of 40 Code of Federal Regulations (CFR) Part 1045 that apply with respect to spark-ignition engines. Manufacturers subject to evaporative emission standards must meet the requirements of 40 CFR 1045.112 as described in 40 CFR 1060.1(a)(2).
- h** Indicates the model years for which the specified standards start.
- i** N is the maximum test speed of the engine in revolutions per minute (rpm).
- j** Manufacturers of Tier 3 engines greater than or equal to 19 kW and less than 75 kW with displacement below 0.9 L/cylinder may alternatively certify some or all of their engine families to a particulate matter (PM) emission standard of 0.20 grams per kilowatt-hour (g/kW-hr) and a NOx+HC emission standard of 5.8 g/kW-hr for 2014 and later model years.
- k** The applicable Tier 2 NOx+HC standards continue to apply instead of the Tier 3 values for engines at or above 2000 kW.

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- l** These Tier 3 standards apply to Category 1 engines below 3700 kW except for recreational marine engines at or above 3700 kW (with any displacement), which must meet the Tier 3 standards specified for recreational marine engines with a displacement of 3.5 to 7.0 L/cylinder.
- m** The following provisions are optional: 1) Manufacturers may use NOx credits to certify Tier 4 engines to a NOX+HC emission standard of 1.9 g/kW-hr instead of the NOX and HC standards. See 40 CFR 1042.101(a)(8)(i) for more details. 2) For engines below 1000 kW, manufacturers may delay complying with the Tier 4 standards until October 1, 2017. 3) For engines at or above 3700 kW, manufacturers may delay complying with the Tier 4 standards until December 31, 2016.
- n** The Tier 4 standard is for HC (not HC+NOx) in g/kW-hr.
- o** These Tier 3 standards apply to Category 2 engines below 3700 kW; no Tier 3 standards apply for Category 2 engines at or above 3700 kW, although there are Tier 4 standards that apply.
- p** An alternative set of Tier 3 and Tier 4 standards for PM, NOx, and HC are available for Category 2 engines at or above 1400 kW, but must be applied to all of a manufacturer's engines in a given displacement category in model years 2012 through 2015.

Tier	Maximum engine power	Model year	PM (g/kW-hr)	NOx (g/kW-hr)	HC (g/kW-hr)
3	kW ≥ 1400	2012-2014	0.14	7.8 NOx+HC	
4	1400 ≤ kW < 3700	2015	0.04	1.8	0.19
	kW ≥ 3700	2015	0.06	1.8	0.19

- q** Interim Tier 4 PM standards apply for 2014 and 2015 model year Category 2 engines with per-cylinder displacement at or above 15.0 liters: 0.34 g/kW-hr for engines 2000 = kW < 3000, and 0.27 g/kW-hr for engines 3300 = kW < 3700.

Code of Federal Regulations (CFR) Citations:

- 40 CFR 89.104 = Tier 1 and Tier 2 useful life & warranty period for marine CI engines less than 37 kW
- 40 CFR 89.112 = Tier 1 and Tier 2 emission standards for marine CI engines less than 37 kW
- 40 CFR Part 89, Subpart E = Tier 1 and Tier 2 test procedures for marine CI engines less than 37 kW
- 40 CFR 94.8 = Tier 1 standards for C3 engines; also, Tier 1 and Tier 2 emission standards for C1 and C2 engines
- 40 CFR 94.9 = Useful life values corresponding to the standards in §94.8
- 40 CFR 94.10 = Warranty periods corresponding to the standards in §94.8
- 40 CFR Part 94, Subpart B = Test procedures for measuring emissions relative to the emission standards in §94.8
- 40 CFR 1042.101 = Tier 3 and Tier 4 exhaust emission standards and useful life for C1 and C2 engines
- 40 CFR 1042.104 = Tier 2 and Tier 3 exhaust emission standards and useful life for C3 engines
- 40 CFR 1042.107 = Evaporative emission standards for marine CI engines using methanol or any other volatile liquid fuel
- 40 CFR 1042.120 = Warranty periods corresponding to the standards in 40 CFR Part 1042
- 40 CFR Part 1042, Subpart F = Test procedures for measuring emissions relative to the emission standards in 40 CFR Part 1042