

# US: MARINE: EMISSIONS

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## History

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Emissions from marine diesel engines (compression ignition engines) have been regulated through a number of rules—the first one issued in 1999—applicable to different engine categories. Certain overlap also exists with the regulations for mobile, land-based nonroad engines, which may be applicable to some types of engines used on marine vessels. The following are the major regulatory acts which establish emission standards for marine engines:

- 1999 Marine Engine Rule - On 23 November 1999, the EPA signed the final rule “Control of Emissions of Air Pollution from New Compression Ignition Marine Engines at or above 37 kW” (40 CFR Part 94). The adopted Tier 2 standards for Category 1 and 2 engines are based on the land-based standard for nonroad engines, while the largest Category 3 engines were expected—but not required by the rule—to comply with IMO MARPOL Annex VI limits.
- 2002 Recreational Engine Rule - Diesel engines used in recreational vessels are covered in the “Emission Standards for New Nonroad Engines—Large Industrial Spark-ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles” regulation, signed on 13 September 2002 (40 CFR Part 89).

- 2003 Category 3 Engine Rule - The decision to leave the largest Category 3 engines unregulated triggered a law suit against the EPA by environmental organizations. A court settlement was reached that required the EPA to develop NO<sub>x</sub> emission limits for Category 3 engines. The final rule “Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters Per Cylinder” [40 CFR Part 9 and 94]—signed by the EPA in January 2003—establishes Tier 1 emission standards for marine engines virtually equivalent to the IMO MARPOL Annex VI limits.
- 2008 Category 1/2 Engine Rule - A regulation signed on 14 March 2008 introduced Tier 3 and Tier 4 emission standards for marine diesel engines. The Tier 4 emission standards are modeled after the 2007/2010 highway engine program and the Tier 4 nonroad rule, with an emphasis on the use of emission aftertreatment technology. To enable catalytic aftertreatment methods, the EPA established a sulfur cap in marine fuels (as part of the nonroad Tier 4 rule). Sulfur limit of 500 ppm became effective in June 2007, sulfur limit of 15 ppm in June 2012 (the sulfur limits are not applicable to residual fuels).
- 2009 Category 3 Engine Rule - On 18 December 2009, the EPA signed a new emission rule for Category 3 engines (published 30 April 2010), which introduced Tier 2 and Tier 3 standards in harmonization with the 2008 Amendments to IMO MARPOL Annex VI.

## **Regulations Applicable to Marine Diesel Engines and Vessels**

|                  |   |
|------------------|---|
| 40 CFR part 1042 | Emission Standards and Certification Requirements—Tier 3 and Tier 4   |
| 40 CFR part 94   | Emission Standards and Certification Requirements—Tier 1 and Tier 2 for engines at or above 37 kW                                       |
| 40 CFR part 89   | Emission Standards and Certification Requirements—Tier 1 and Tier 2 for engines below 37 kW   |
| 40 CFR part 1065 | Engine Exhaust Emission Test Procedures   |
| 40 CFR part 1068 | General Compliance Provisions   |
| 40 CFR part 1043 | Regulations implementing MARPOL Annex VI, including requirements for in-use fuels, engines above 130 kW, and vessels with those engines |

## **Applicability**

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### **1999 Marine Engine Rule**

The scope of application of the marine engine rule covers all new marine diesel engines at or above 37 kW (50 hp) (engines below 37 kW must comply with the nonroad standards). Regulated engines include both propulsion and auxiliary marine diesel engines. A propulsion engine is one that moves a vessel through the water or assists in guiding the direction of the vessel (for example, bow thrusters). Auxiliary engines are all other marine engines.

Classification of drilling rigs depends on their propulsion capability. Drilling ships are considered marine vessels, so their engines are subject to the marine rule.

Semi-submersible drilling rigs which are moored to the ocean bottom, but have some propulsion capability, are also considered marine vessels.

In contrast, permanently anchored drilling platforms are not considered marine vessels, so none of the engines associated with one of these facilities are marine engine.

Consistently with the land-based nonroad regulation, a portable auxiliary engine that is used onboard a marine vessel is not considered to be a marine engine.

Instead, a portable auxiliary engine is considered to be a land-based auxiliary engine and is subject to the land-based nonroad requirements. To distinguish a marine auxiliary engine installed on a marine vessel from a land-based portable auxiliary engine used on a marine vessel, EPA specified in the rulemaking that an auxiliary engine is installed on a marine vessel if its fuel, cooling, or exhaust system are an integral part of the vessel or require special mounting hardware. All other auxiliary engines are considered to be portable and therefore land-based.

The following engine categories are exempted from the 1999 marine regulation:

- Engines used in recreational vessels (standards for recreational diesel engines were established by the 2002 rule)
- Emission certified new land-based engines modified for marine applications (provided certain conditions are met)
- Competition (racing) engines
- Engines used in military vessels (National Security Exemption)

- Other exemptions (testing, display, export, ...) may also apply to marine engines.

The 1999 rule also included a Foreign-Trade Exemption, which was available (for engines Category 1 and 2 used on ocean vessels with Category 3 propulsion) for US vessels that spend less than 25% of total operating time within 320 kilometers of US territory. The Foreign-Trade Exemption was eliminated for all engine categories by the 2003 (Category 3) regulation.

Under the 1999 rule, the same emission standards apply to engines fueled by diesel fuel and by other fuels.

### **2002 Recreational Vessel Rule**

This rule applies to new recreational marine diesel engines over 37 kW (50 hp) that are used in yachts, cruisers, and other types of pleasure craft. The 2002 rule does not apply to outboard and personal watercraft *spark ignited* engines, which are regulated separately.

The same emission standards apply to recreational engines fueled by diesel fuel and by alternative fuels.

### **Category 3 Engines, 2003 & 2009 Rules**

These standards apply to new marine engines and to new vessels that include marine engines. The rules apply only to vessels flagged or registered in the USA.

However, equivalent emission standards are applicable to foreign ships in US waters under the IMO Annex VI regulation.

### **2008 Category 1/2 Engines Rule**

The regulations introduce two tiers of standards—Tier 3 and Tier 4—which apply to both newly manufactured and remanufactured marine diesel engines, as follows:

1. *Newly-built engines*: Tier 3 standards apply to engines used in commercial, recreational, and auxiliary power applications (including those below 37 kW that were previously covered by nonroad engine standards). Tier 4 standards, based on aftertreatment, apply to engines above 600 kW (800 hp) on commercial vessels.
2. *Remanufactured engines*: The standards apply to commercial marine diesel engines above 600 kW when these engines are remanufactured.

The 2008 rule includes exemptions for the following engine categories:

- Test engines, manufacturer-owned engines, display engines;
- Marine diesel engines that are produced by marinizing a certified highway, nonroad, or locomotive engine (“dresser exemption”);
- Competition engines;
- Export engines;

- Certain military engines;
- Engines installed on a vessel manufactured by a person for his/her own use (intended to allow hobbyists and fishermen to install a used/rebuilt engine or a reconditioned vintage engine—not to order a new uncontrolled engine from an engine manufacturer).

Not all exemptions are automatic. Engine or vessel manufacturers, or vessel owners, may need to apply for a specific exemption to the EPA.

## Technical Standards

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### Engine Categories

For the purpose of emission regulations, marine engines are divided into three categories based on displacement (swept volume) per cylinder. Each of the categories represents a different engine technology. Categories 1 and 2 are further divided into subcategories, depending on displacement and net power output.

| Marine Engine Categories                 |   |   |                             |
|--|---|---|-----------------------------|
| Category                                 | Displacement per Cylinder (D)             |   | Basic Engine Technology     |
|  | Tier 1-2                                  | Tier 3-4                                  |                             |
| 1  | $D < 5 \text{ dm}^3 \dagger$              | $D < 7 \text{ dm}^3$                      | Land-based nonroad diesel   |
| 2  | $5 \text{ dm}^3 \leq D < 30 \text{ dm}^3$ | $7 \text{ dm}^3 \leq D < 30 \text{ dm}^3$ | Locomotive engine           |
| 3  | $D \geq 30 \text{ dm}^3$                  |   | Unique marine engine design |
| $\dagger$ And power $\geq 37 \text{ kW}$ |   |   |                             |

Category 1 and Category 2 marine diesel engines typically range in size from about 500 to 8,000 kW (700 to 11,000 hp).

These engines are used to provide propulsion power on many kinds of vessels including tugboats, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. They are also used as stand-alone generators for auxiliary electrical power on many types of vessels.

## **Category 1 And 2**

### **Tier 1-2 Standards**

Emission standards for engines Category 1 and 2 are based on the land-based standard for nonroad and locomotive engines. The emission standards, referred to as Tier 2 Standards by the EPA, and their implementation dates are listed in the following table. The Tier 1 NO<sub>x</sub> standard, equivalent to MARPOL Annex VI, was voluntary under the 1999 rule, but was made mandatory by the 2003 (Category 3) rule for Category 2 and Category 1 engines of above 2.5 liter displacement per cylinder, effective 2004.

The regulated emissions include NO<sub>x</sub>+THC, PM, and CO. There are no smoke requirements for marine diesel engines. The regulators believed that the new PM standards will have a sufficient effect on limiting smoke emissions.

| <b>Tier 2* Marine Emission Standards</b> |                                    |              |                           |              |             |
|--|------------------------------------|--------------|---------------------------|--------------|-------------|
| <b>Category</b>                          | <b>Displacement (D)</b>            | <b>CO</b>    | <b>NO<sub>x</sub>+THC</b> | <b>PM</b>    | <b>Date</b> |
|  | <i>dm<sup>3</sup> per cylinder</i> | <i>g/kWh</i> | <i>g/kWh</i>              | <i>g/kWh</i> |             |
| 1  | Power ≥ 37 kW                      | 5.0          | 7.5                       | 0.40         | 2005        |



|   |                                |     |      |      |                   |
|---|--------------------------------|-----|------|------|-------------------|
|   | D < 0.9                        |     |      |      |                   |
|   | 0.9 ≤ D < 1.2                  | 5.0 | 7.2  | 0.30 | 2004              |
|   | 1.2 ≤ D < 2.5                  | 5.0 | 7.2  | 0.20 | 2004              |
|   | 2.5 ≤ D < 5.0                  | 5.0 | 7.2  | 0.20 | 2007 <sup>a</sup> |
| 2   | 5.0 ≤ D < 15                   | 5.0 | 7.8  | 0.27 | 2007 <sup>a</sup> |
|   | 15 ≤ D < 20<br>Power < 3300 kW | 5.0 | 8.7  | 0.50 | 2007 <sup>a</sup> |
|   | 15 ≤ D < 20<br>Power ≥ 3300 kW | 5.0 | 9.8  | 0.50 | 2007 <sup>a</sup> |
|   | 20 ≤ D < 25                    | 5.0 | 9.8  | 0.50 | 2007 <sup>a</sup> |
|   | 25 ≤ D < 30                    | 5.0 | 11.0 | 0.50 | 2007 <sup>a</sup> |
| * - Tier 1 standards are equivalent to the MARPOL Annex VI Tier I NO <sub>x</sub> limits<br>a - Tier 1 certification requirement starts in 2004 |                                |     |      |      |                   |

In the earlier proposal, the EPA also listed a more stringent Tier 3 standard to be introduced between 2008 and 2010. The Tier 3 standard was not adopted in the final 1999 rule.

### Blue Sky Series Program

The 1999 regulation sets a voluntary “Blue Sky Series” program which permits manufacturers to certify their engines to more stringent emission standards. The Blue Sky program begins upon the publication of the rule and extends through the year 2010.

| <b>“Blue Sky Series” Voluntary Emission Standards</b> |                           |              |
|---|---------------------------|--------------|
| <b>Displacement (D)</b>                               | <b>NO<sub>x</sub>+THC</b> | <b>PM</b>    |
| <i>dm<sup>3</sup> per cylinder</i>                    | <i>g/kWh</i>              | <i>g/kWh</i> |
| Power ≥ 37 kW & D < 0.9                               | 4.0                       | 0.24         |
| 0.9 ≤ D < 1.2   | 4.0                       | 0.18         |
| 1.2 ≤ D < 2.5   | 4.0                       | 0.12         |
| 2.5 ≤ D < 5.0   | 5.0                       | 0.12         |

|   |     |      |
|---|-----|------|
| $5.0 \leq D < 15$                       | 5.0 | 0.16 |
| $15 \leq D < 20$ & Power < 3300 kW      | 5.2 | 0.30 |
| $15 \leq D < 20$ & Power $\geq$ 3300 kW | 5.9 | 0.30 |
| $20 \leq D < 25$                        | 5.9 | 0.30 |
| $25 \leq D < 30$                        | 6.6 | 0.30 |

## 2002 Recreational Vessels Rule

Recreational vessels standards are phased-in beginning in 2006, depending on the size of the engine as listed below. These standards are similar to the Tier 2 standards for Category 1 commercial vessels.

| Recreational Marine Diesel Engines Standards |              |                     |              |      |
|--|--------------|---------------------|--------------|------|
| Displacement (D)                             | CO           | NO <sub>x</sub> +HC | PM           | Date |
| <i>dm<sup>3</sup> per cylinder</i>           | <i>g/kWh</i> | <i>g/kWh</i>        | <i>g/kWh</i> |      |
| $0.5 \leq D < 0.9$                           | 5.0          | 7.5                 | 0.40         | 2007 |
| $0.9 \leq D < 1.2$                           | 5.0          | 7.2                 | 0.30         | 2006 |
| $1.2 \leq D < 2.5$                           | 5.0          | 7.2                 | 0.20         | 2006 |
| $D \geq 2.5$                                 | 5.0          | 7.2                 | 0.20         | 2009 |

Recreational engines are also subject to NTE limits. There are no smoke requirements for recreational marine diesel engines. Similarly to commercial vessels, a voluntary “Blue Sky Series” limits exist for recreational vessels, which are based on a 45% emission reduction beyond the mandatory standards.

## Tier 3-4 Standards

The standards and implementation schedules are shown below. The engine-based Tier 3 standards are phasing in over 2009-2014.

The aftertreatment-based Tier 4 standards for commercial marine engines at or above 600 kW are phasing in over 2014-2017. For engines of power levels not included in the Tier 3 and Tier 4 tables, the previous tier of standards—Tier 2 or Tier 3, respectively—continues to apply.

A differentiation is made between *high power density* engines typically used in planing vessels and *standard power density* engines, with a cut point between them at 35 kW/dm<sup>3</sup> (47 hp/dm<sup>3</sup>).

| <b>Tier 3 Standards for Marine Diesel Category 1 Commercial Standard Power Density (<math>\leq 35</math> kW/dm<sup>3</sup>) Engines</b>  |                                    |                                      |                   |             |
|--|------------------------------------|--------------------------------------|-------------------|-------------|
| <b>Power (P)</b>   | <b>Displacement (D)</b>            | <b>NO<sub>x</sub>+HC<sup>†</sup></b> | <b>PM</b>         | <b>Date</b> |
| <i>kW</i>  | <i>dm<sup>3</sup> per cylinder</i> | <i>g/kWh</i>                         | <i>g/kWh</i>      |             |
| P < 19   | D < 0.9                            | 7.5                                  | 0.40              | 2009        |
| 19 ≤ P < 75  | D < 0.9 <sup>a</sup>               | 7.5                                  | 0.30              | 2009        |
|  |                                    | 4.7 <sup>b</sup>                     | 0.30 <sup>b</sup> | 2014        |
| 75 ≤ P < 3700  | D < 0.9                            | 5.4                                  | 0.14              | 2012        |
|  | 0.9 ≤ D < 1.2                      | 5.4                                  | 0.12              | 2013        |
|  | 1.2 ≤ D < 2.5                      | 5.6                                  | 0.11 <sup>c</sup> | 2014        |
|  | 2.5 ≤ D < 3.5                      | 5.6                                  | 0.11 <sup>c</sup> | 2013        |
|  | 3.5 ≤ D < 7                        | 5.8                                  | 0.11 <sup>c</sup> | 2012        |
| <sup>†</sup> Tier 3 NO <sub>x</sub> +HC standards do not apply to 2000-3700 kW engines.<br>a - < 75 kW engines ≥ 0.9 dm <sup>3</sup> /cylinder are subject to the corresponding 75-3700 kW standards.<br>b - Option: 0.20 g/kWh PM & 5.8 g/kWh NO <sub>x</sub> +HC in 2014.<br>c - This standard level drops to 0.10 g/kWh in 2018 for < 600 kW engines. |                                    |                                      |                   |             |
| <b>Tier 3 Standards for Marine Diesel Category 1 Commercial High Power Density (&gt; 35 kW/dm<sup>3</sup>) Engines And All Diesel Recreational Engines</b>   |                                    |                                      |                   |             |
| <b>Power (P)</b>   | <b>Displacement (D)</b>            | <b>NO<sub>x</sub>+HC</b>             | <b>PM</b>         | <b>Date</b> |
| <i>kW</i>  | <i>dm<sup>3</sup> per cylinder</i> | <i>g/kWh</i>                         | <i>g/kWh</i>      |             |
| P < 19   | D < 0.9                            | 7.5                                  | 0.40              | 2009        |

|                    |                    |                  |                   |      |
|--------------------|--------------------|------------------|-------------------|------|
| $19 \leq P < 75$   | $D < 0.9^a$        | 7.5              | 0.30              | 2009 |
|                    |                    | 4.7 <sup>b</sup> | 0.30 <sup>b</sup> | 2014 |
| $75 \leq P < 3700$ | $D < 0.9$          | 5.8              | 0.15              | 2012 |
|                    | $0.9 \leq D < 1.2$ | 5.8              | 0.14              | 2013 |
|                    | $1.2 \leq D < 2.5$ | 5.8              | 0.12              | 2014 |
|                    | $2.5 \leq D < 3.5$ | 5.8              | 0.12              | 2013 |
|                    | $3.5 \leq D < 7$   | 5.8              | 0.11              | 2012 |

a - < 75 kW engines  $\geq 0.9$  dm<sup>3</sup>/cylinder are subject to the corresponding 75-3700 kW standards.  
b - Option: 0.20 g/kWh PM & 5.8 g/kWh NO<sub>x</sub>+HC in 2014.

| <b>Tier 3 Standards for Marine Diesel Category 2 Engines‡</b> |                                    |                           |                   |             |
|---|------------------------------------|---------------------------|-------------------|-------------|
| <b>Power (P)</b>  | <b>Displacement (D)</b>            | <b>NO<sub>x</sub>+HC†</b> | <b>PM</b>         | <b>Date</b> |
| <i>kW</i>   | <i>dm<sup>3</sup> per cylinder</i> | <i>g/kWh</i>              | <i>g/kWh</i>      |             |
| $P < 3700$  | $7 \leq D < 15$                    | 6.2                       | 0.14              | 2013        |
|   | $15 \leq D < 20$                   | 7.0                       | 0.27 <sup>a</sup> | 2014        |
|   | $20 \leq D < 25$                   | 9.8                       | 0.27              | 2014        |
|   | $25 \leq D < 30$                   | 11.0                      | 0.27              | 2014        |

‡ Option: Tier 3 PM/NO<sub>x</sub>+HC at 0.14/7.8 g/kWh in 2012, and Tier 4 in 2015.  
† Tier 3 NO<sub>x</sub>+HC standards do not apply to 2000-3700 kW engines.  
a - 0.34 g/kWh for engines below 3300 kW.

In addition to the above NO<sub>x</sub>+HC and PM standards, the following CO emission standards apply for all Category 1/2 engines starting with the applicable Tier 3 model year:

1. 8.0 g/kWh for engines < 8 kW,
2. 6.6 g/kWh for engines  $\geq 8$  kW and < 19 kW,
3. 5.5 g/kWh for engines  $\geq 19$  kW and < 37 kW,
4. 5.0 g/kWh for engines  $\geq 37$  kW.

| <b>Tier 4 Standards for Marine Diesel Category 1/2 Engines</b> |              |              |                   |                     |
|--|--------------|--------------|-------------------|---------------------|
| <b>Power (P)</b>   | <b>NOx</b>   | <b>HC</b>    | <b>PM</b>         | <b>Date</b>         |
| <i>kW</i>  | <i>g/kWh</i> | <i>g/kWh</i> | <i>g/kWh</i>      |                     |
| P ≥ 3700   | 1.8          | 0.19         | 0.12 <sup>a</sup> | 2014 <sup>c</sup>   |
|  | 1.8          | 0.19         | 0.06              | 2016 <sup>b,c</sup> |
| 2000 ≤ P < 3700  | 1.8          | 0.19         | 0.04              | 2014 <sup>c,d</sup> |
| 1400 ≤ P < 2000  | 1.8          | 0.19         | 0.04              | 2016 <sup>c</sup>   |
| 600 ≤ P < 1400   | 1.8          | 0.19         | 0.04              | 2017 <sup>d</sup>   |

a - 0.25 g/kWh for engines with 15-30 dm<sup>3</sup>/cylinder displacement.  
b - Optional compliance start dates can be used within these model years.  
c - Option for Cat. 2: Tier 3 PM/NOx+HC at 0.14/7.8 g/kWh in 2012, and Tier 4 in 2015.  
d - The Tier 3 PM standards continue to apply for these engines in model years 2014 and 2015 only.

### **Category 3**

#### **Tier 1 Standards**

In the 2003 rule, EPA adopted Tier 1 NOx emission standards for Category 3 engines, which are equivalent to the international IMO MARPOL Annex VI limits. These limits range from 17 to 9.8 g/kWh depending on the engine speed, with higher limits for slower engines.

The EPA Tier 1 limits are in effect for new engines built in 2004 and later. These limits are to be achieved by engine-based controls, without the need for exhaust gas aftertreatment. Emissions other than NOx are not regulated.

#### **Tier 2-3 Standards**

In the 2009 rule, EPA has adopted Tier 2 and Tier 3 emission standards for newly built Category 3 engines.

- Tier 2 standards apply beginning in 2011. They require the use of engine-based controls, such as engine timing, engine cooling, and advanced electronic controls. The Tier 2 standards result in a 15 to 25% NO<sub>x</sub> reduction below the Tier 1 levels.
- Tier 3 standards apply beginning in 2016. They can be met with the use of high efficiency emission control technology such as selective catalytic reduction (SCR) to achieve NO<sub>x</sub> reductions 80% below the Tier 1 levels.

The EPA Tier 2-3 NO<sub>x</sub> limits are equivalent to the respective IMO Tier II-III standards. Depending on the engine speed, Tier 2 limits range from 14.4 to 7.7 g/kWh, while Tier 3 limits range from 3.4 to 1.96 g/kWh. In addition to the NO<sub>x</sub> limits, EPA adopted a HC emission standard of 2.0 g/kWh and a CO standard of 5.0 g/kWh from new Category 3 engines. No emission standard was adopted for PM, but manufacturers are required to measure and report PM emissions.

*IMO Emission Control Areas (ECA)* - The IMO has designated waters along the US and Canadian shorelines as the North American ECA for the emissions of NO<sub>x</sub> and SO<sub>x</sub> (enforceable from August 2012) and waters surrounding Puerto Rico and the US Virgin Islands as the US Caribbean ECA for NO<sub>x</sub> & SO<sub>x</sub> (enforceable from 2014).

The ECAs ensure that foreign flagged vessels comply with IMO Tier III NO<sub>x</sub> limits while in US waters (the IMO Tier III standards are only applicable within

ECAs). The ECA also triggers low sulfur fuel requirements—by IMO and US EPA—for vessels in US waters.

## **Emissions Testing**

### **Category 1/2 Engines**

Emissions from Category 1 engines are tested using the nonroad (Tier 1-3) test procedures (40 CFR 89), while Category 2 engines are tested using the locomotive test procedures (40 CFR 92), with certain exceptions including different test cycles, certification fuels and NTE testing. Category 1/2 engines are tested on various ISO 8178 test cycles.

| <b>Test Cycles for Certifying Category 1/2 Marine Diesel Engines</b>                                     |                   |
|--|-------------------|
| <b>Application</b>   | <b>Test Cycle</b> |
| General Marine Duty Cycle  | ISO 8178 E3       |
| Constant-Speed Propulsion Engines  | ISO 8178 E2       |
| Variable Speed Propulsion Engines Used on Non-Propeller Law Vessels and Variable Speed Auxiliary Engines | ISO 8178 C1       |
| Constant-Speed Auxiliary Engines   | ISO 8178 D2       |
| Recreational Marine  | ISO 8178 E5       |

In addition to the test cycle measurement, which is an averages from several test modes, the regulations set “not-to-exceed” (NTE) emission limits, which provide assurance that emissions at any engine operating conditions within an NTE zone are reasonably close to the average level of control. NTE zones are defined as areas on the engine speed-power map.

The emission caps within the NTE zones represent a multiplier (Tier 1/2: between 1.2 and 1.5; Tier 3/4: 1.2-1.9) times the weighted test result used for certification for all of the regulated pollutants (NO<sub>x</sub>+THC, CO, and PM).

The test fuel for marine diesel engine testing has a sulfur specification range of 0.03 to 0.80 %wt, which covers the range of sulfur levels observed for most in-use fuels.

### **Category 3 Engines**

Category 3 engines are tested using methods similar to those stipulated by IMO MARPOL Annex VI (E2 and E3 cycles of the ISO 8178 test). The major differences between the EPA and MARPOL compliance requirements are: (1) EPA liability for in-use compliance rests with the engine manufacturer (it is the vessel operator in MARPOL), (2) EPA requires a durability demonstration (under MARPOL, compliance must be demonstrated only when the engine is installed in the vessel), (3) there are differences in certain test conditions and parameters in EPA and MARPOL testing (air and water temperatures, engine setting, etc.).

Category 3 engines have no NTE emission limits or test requirements.

Category 3 engines can be tested using distillate fuels, even though vessels with Category 3 marine engines use primarily residual fuels (this allowance is consistent with MARPOL Annex VI).



## **Other Provisions**

**Useful life and warranty** periods for marine engines are listed below. The periods are specified in operating hours and in years, whichever occurs first. The relatively short useful life period for Category 3 engines is based on the time that engines operate before being rebuilt for the first time.

| <b>Useful Life and Emission Warranty Periods</b> |                    |              |                        |              |
|--|--------------------|--------------|------------------------|--------------|
| <b>Category</b>                                  | <b>Useful Life</b> |              | <b>Warranty Period</b> |              |
|  | <i>hours</i>       | <i>years</i> | <i>hours</i>           | <i>years</i> |
| Category 3                                       | 10,000             | 3            | 10,000                 | 3            |
| Category 2                                       | 20,000             | 10           | 10,000                 | 5            |
| Category 1                                       | 10,000             | 10           | 5,000                  | 5            |
| Recreational                                     | 1,000              | 10           | 500                    | 3            |

The periods in the table are the minimum periods specified by the regulations. In certain cases, longer useful life/warranty periods may be required (e.g., in most cases the emission warranty must not be shorter than the warranty for the engine or its components).

The regulations contain several other provisions, such as emission Averaging, Banking, and Trading (ABT) program, deterioration factor requirements, production line testing, in-use testing, and requirements for rebuilding of emission certified engines.

Source: [http://transportpolicy.net/index.php?title=US:\\_Marine:\\_Emissions](http://transportpolicy.net/index.php?title=US:_Marine:_Emissions)