INTERNATIONAL: MARINE: EMISSIONS

History

The International Maritime Organization (IMO) is an agency of the United Nations formed to promote maritime safety. It was formally established by an international conference in Geneva in 1948, and became active in 1958 when the IMO Convention entered into force. The original name was the Inter-Governmental Maritime Consultative Organization (IMCO) but the name was changed in 1982 to IMO. IMO currently consists of 170 Member States and 3 Associate Members.

Major treaties related to Air Pollution from Ocean-going Ships	
Name of Treaty	**Date and Key Events**
International Maritime Organization	1948 - Convention establishes IMO
	1958 Ratifies: Enters into force
International Convention on Prevention of Pollution from Ships (MARPOL 73/78)	1973 - Codified
	1978 Amended and Codified
United Nations Convention on the Law of the Sea (UNCLOS)	1973 - First meeting of the United Nations Convention
	1982 - Codified
	1994 - Ratified: Enters into force
MARPOL Annex VI (Regulations for the Prevention of Air Pollution from Ships)	1997 - Codified
	2005 - Ratified: Enters into force

IMO ship pollution rules are contained in the *International Convention on the Prevention of Pollution from Ships*, known as MARPOL 73/78.

On 27 September 1997, the MARPOL Convention was amended by the "1997 Protocol," which added Annex VI: *Regulations for the Prevention of Air Pollution from Ships*. MARPOL Annex VI sets limits on NOx and SOx emissions from ship exhausts, and prohibits deliberate emissions of ozone depleting substances.

The IMO emission standards are commonly referred to as Tier I...III standards. The Tier I standards were defined in the 1997 version of Annex VI, while the Tier II/III standards were introduced by Annex VI amendments adopted in 2008.

Key actions:

- **1997 Protocol (Tier I)**—The "1997 Protocol" to MARPOL, which includes Annex VI, became effective 12 months after being accepted by 15 States with not less than 50% of world merchant shipping tonnage. On 18 May 2004, Samoa deposited its ratification as the 15th State (joining Bahamas, Bangladesh, Barbados, Denmark, Germany, Greece, Liberia, Marshall Islands, Norway, Panama, Singapore, Spain, Sweden, and Vanuatu). At that date, Annex VI was ratified by States with 54.57% of world merchant shipping tonnage.

  Accordingly, Annex VI entered into force on 19 May 2005. It applies retroactively to new engines greater than 130 kW installed on vessels constructed on or after 1 January 2000, or engines which undergo a major conversion after 1 January 2000.

The regulation also applies to fixed and floating rigs and to drilling platforms (except for emissions associated directly with exploration and/or handling of sea-bed minerals). In anticipation of the Annex VI ratification, most marine engine manufacturers began building engines compliant with the above standards since 2000.

- **2008 Amendments (Tier II/III)**—Annex VI amendments adopted in October 2008 introduced (1) new fuel quality requirements beginning from July 2010, (2) Tier II and III NOx emission standards for new engines, and (3) Tier I NOx requirements for existing pre-2000 engines.

  The revised Annex VI entered into force on 1 July 2010. By October 2008, Annex VI was ratified by 53 countries (including the United States), representing 81.88% of tonnage.

Emission Control Areas

Two sets of emission and fuel quality requirements are defined by Annex VI: (1) global requirements, and (2) more stringent requirements applicable to ships in Emission Control Areas (ECA). An ECA can be designated for SOx and PM, or NOx, or all three types of emissions from ships, subject to a proposal from a Party to Annex VI.

In accordance with MARPOL Annex VI, an ECA may be proposed if there is need to prevent, reduce, and control air pollution from ships, demonstrated by eight specific criteria. [1]

The table below shows the existing ECAs worldwide and the pollutants that are controlled in those areas.

Existing Emission Control Areas			
Area	**Pollutant(s) Controlled**	**Date**	
		Adopted	**Entered into Force**
Baltic Sea	SOx	1997	2005
North Sea	SOx	2005	2006
North American ECA, including most of US and Canadian coast	NOx, SOx, & PM	2010	2012
US Caribbean ECA, including Puerto Rico and the US Virgin Islands	NOx, SOx, & PM	2011	2014

Greenhouse Gas Emissions

Amendments to MARPOL Annex VI in 2011 introduced mandatory measures to reduce emissions of greenhouse gases (GHG). The Amendments added a new Chapter 4 to Annex VI on “Regulations on energy efficiency for ships.” For more information, see the International Marine GHG emissions page.

Technical Standards

NOx Emission Standards

NOx emissions from diesel engines are controlled through specific requirements under the Engine International Air Pollution Prevention (EIAPP) Certificate program, as well as compliance with in-service requirements under regulations 13.8 and 5.3.2 of the NOx Technical Code 2008 (resolution MEPC.177(58)).

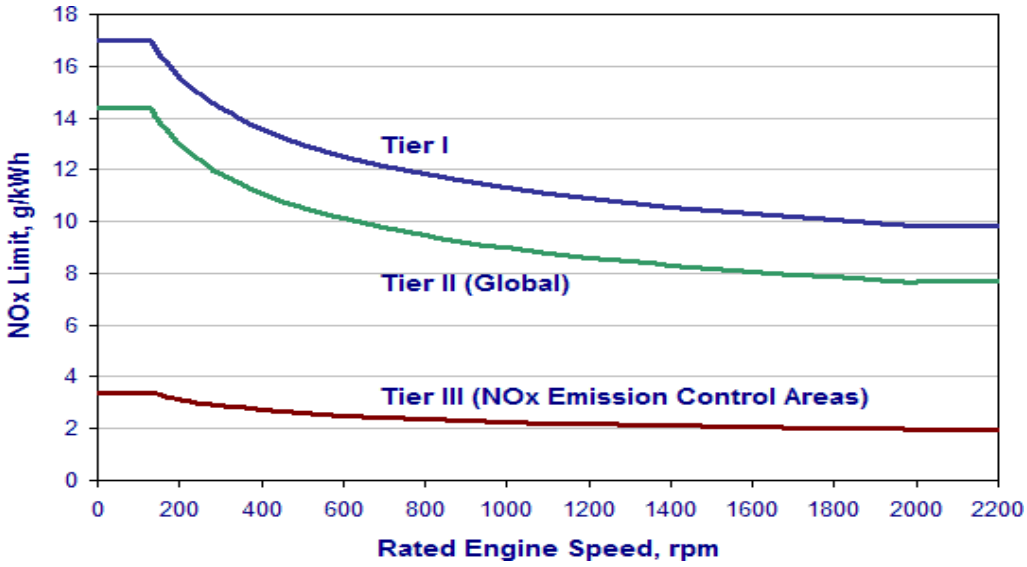
NOx emission limits (Regulation 13) are set for diesel engines depending on the engine maximum operating speed (n, rpm). Tier I and Tier II limits are global, while the Tier III standards apply only in NOx ECAs. See table below.

MARPOL Annex VI NOx Emission Limits

Tier	Ship construction date on or after	NOx Limit, g/kWh		
		n < 130	130 ≤ n < 2000	n ≥ 2000
I	2000	17.0	$45 \cdot n^{-0.2}$	9.8
II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
III†	2016*	3.4	$9 \cdot n^{-0.2}$	2.0

Notes:
† Tier III standards apply only in NOx ECAs; Tier II controls apply outside NOx ECAs
* subject to a technical review to be concluded in 2013 this date could be delayed to 2021, regulation 13.10

The figure below illustrates NOx emission limits based on the operating speed for different engine categories.



MARPOL Annex VI NOx Emission Limits

Tier II standards are expected to be met by technologies such as combustion process optimization and emulsified fuel. The parameters examined by engine manufacturers include fuel injection timing, pressure, and rate (rate shaping), fuel nozzle flow area, exhaust valve timing, and cylinder compression volume.

Tier III standards are expected to require dedicated NOx emission control technologies such as exhaust gas recirculation, selective catalytic reduction, and liquefied natural gas.

Pre-2000 Engines

Under the 2008 Annex VI amendments, Tier I standards become applicable to existing engines installed on ships built between 1 January 1990 and 31 December 1999, with a displacement ≥ 90 liters per cylinder and rated output ≥ 5000 kW, subject to availability of approved engine upgrade kit.

Testing

Engine emissions are tested on various ISO 8178 cycles (E2, E3 cycles for various types of propulsion engines, D2 for constant speed auxiliary engines, C1 for variable speed and load auxiliary engines). Addition of not-to-exceed (NTE) testing requirements to the Tier III standards is being debated. NTE limits with a multiplier of 1.5 would be applicable to NOx emissions at any individual load point in the E2/E3 cycle.

Engines are tested using distillate diesel fuels, even though residual fuels are usually used in real life operation.

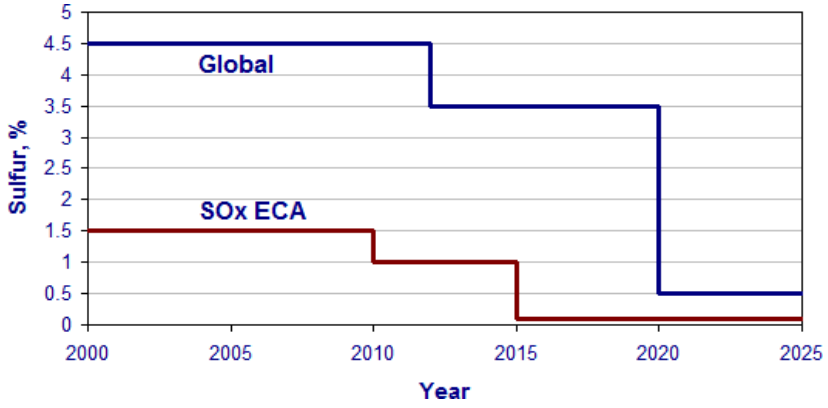
Further technical details pertaining to NOx emissions, such as emission control methods, are included in the mandatory NOx Technical Code, adopted under "Resolution 2."

3.2 Sulfur Content of Fuel

Annex VI regulations include caps on sulfur content of fuel oil (Regulation 14) as a measure to control SOx emissions and, indirectly, PM emissions (there are no explicit PM emission limits). Special fuel quality provisions exist for SOx Emission Control Areas (SOx ECA or SECA).

MARPOL Annex VI Fuel Sulfur Limits		
Date	**Sulfur Limit in Fuel (% m/m)**	
	SOx ECA	**Global**
Jan 2000	1.5%	4.5%
Jul 2010	1.0%	
Jan 2012		3.5%
Jan 2015	0.1%	
Jan 2020[a]		0.5%
a - alternative date is 2025, to be decided by a review in 2018		

The figure below illustrates sulfur limits for ECAs and non-ECAs.



MARPOL Annex VI Fuel Sulfur Limits

Most ships that operate both inside and outside SECAs will use different fuels to comply with the standards. Before entering the SECA, the vessel must switch to using the ECA-compliant oil, as well as possess written procedures on the process. Switching back to non-SECA compliant fuel should not occur until the vessel has left the SECA.

Quantities of each fuel, date, time, and position of the ship must be recorded in the ship's logbook at each entry or exit.

Control Measures

Fuel control measures

One of control is on the sulphur content of the fuel oils. The sulfur value should be recorded by the supplier at the time of delivery, per Regulation 18. It is the ship's responsibility to ensure that the proper fuel is being used inside and outside the SECA. Heavy fuel oil (HFO) is allowed provided it meets the applicable sulfur limit (i.e., there is no mandate to use distillate fuels).

Alternative control measures

- Primary, in which SOx nor PM are created. There are no guidelines for use of any primary methods
- Secondary, in which SOx and/or PM are created but removed prior to release, such as through the use of scrubbers. For example, in lieu of using the 1.5% S fuel in SOx ECAs, ships can fit an exhaust gas cleaning system or use any other technological method to limit SOx emissions to ≤ 6 g/kWh (as SO_2).

Other Provisions

Ozone Depleting Substances

Annex VI prohibits deliberate emissions of ozone depleting substances, which include halons and chlorofluorocarbons (CFCs). New installations containing ozone-depleting substances are prohibited on all ships. But new installations containing hydro-chlorofluorocarbons (HCFCs) are permitted until 1 January 2020.

Annex VI also prohibits the incineration on board ships of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs).

Compliance

Compliance with the provisions of Annex VI is determined by periodic inspections and surveys. Upon passing the surveys, the ship is issued an "International Air Pollution Prevention Certificate", which is valid for up to 5 years. Under the *NOx Technical Code* (Resolution MEPC.177(58)), the ship operator (not the engine manufacturer) is responsible for in-use compliance.

Source:
http://transportpolicy.net/index.php?title=International:_Marine:_Emissions