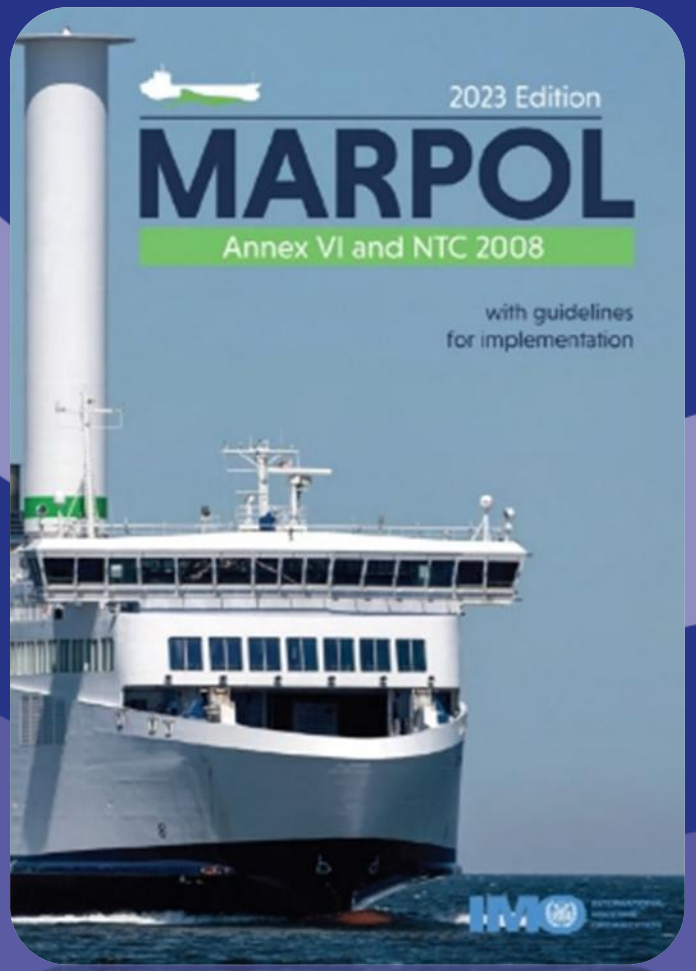
Agenda Item 3 – Overview of MARPOL Annex VI & NO_x Technical Code
Part 2

Regional Expert Meeting on the Possible Designation of the Mediterranean, as a whole, as a Nitrogen Oxides Emission Control Area (Med NOx ECA), Malta, 18 to 19 November 2025

Marie Caillerie, consultant for REMPEC

November 2025



Content of this presentation

Agenda item 3
Overview of MARPOL Annex VI & NO_x Technical Code Part 2

- **Key technical provisions** of MARPOL Annex VI and NO_x Technical Code, with an introduction to **technical notions** (marine diesel engines)
- **NO_x and SO_x:** regulatory framework, Emission Control Areas, NO_x Technical Code
- **Ozone depleting substances**
- **Volatile organic compounds**
- **Incineration**
- **Fuel oil quality and availability**
- **Carbon intensity**
- **Other aspects** in relation to enforcement of MARPOL Annex VI

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Technical provisions in MARPOL Annex VI

Ozone Depleting Substances ODS

⇒ Refrigerant

Volatile Organic Compounds VOC

⇒ Tankers cargo

Nitrogen Oxides
NO_x – regulation 13
⇒ Engine design

Shipboard incineration
Reception facilities

⇒ Operational

Sulphur Oxides (SO_x) and Particulate Matters PM

⇒ Engine fuels

Fuel quality and Availability

⇒ Engine Fuels

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Technical information
Marine engines

Technical information

Formation of NO_x onboard a ship – Recap'

- Oxides of nitrogen include mostly NO and NO_2
- Formed **during fuel combustion** where O_2 and N_2 meet at high temperature.
- Higher temperature (and longer exposure time) = **more** NO_x is formed
  - And…higher temperature in the engine (typically > 1300°C) = **more efficient engine** = but more NO_x …
- Marine engines are efficient = they produce more NO_x **compared to other types of** engines and combustion systems
- NO_x emitted from **other sources** (boilers, dual fuel engines, gas turbines) are relatively small due to the type of combustion.

NO_x contribute to
- *ground-level **ozone** formation*
- ***smog** formation*
- ***health** issues; in particular on respiratory system*
- ***global warming + acid rain***

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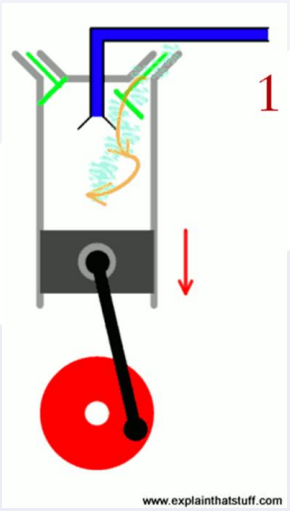
Technical information

Marine Diesel Engines

Most common onboard ships:

- **Thermal engines** = Internal combustion engines
  - **Diesel** cycle or **Otto** cycle
  - **4**-stroke or **2**-stroke

Other propulsion engines exist, but **only "marine diesel engines"** are covered by reg. 13.



Diesel cycle?

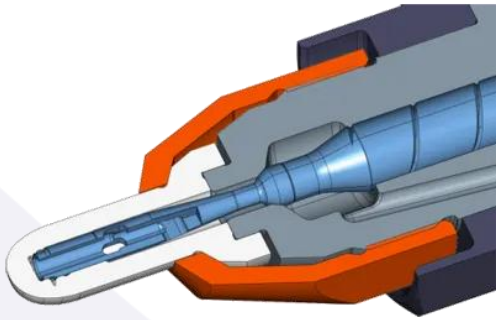
1. **Intake**: Air into the cylinder through the air inlet valve. Piston moves down.
2. **Compression**: Piston moves up, compression of the air mixture, heats up. Fuel injected through the fuel nozzle.
3. **Power stroke**: As the air-fuel mixture ignites and burns, it pushes the piston down, driving the crankshaft.
4. **Exhaust**: Exhaust valve opens, gases are pushed out by the returning piston.

Technical information

Marine Diesel Engine – Parts that most impact NO_x formation

- **Fuel oil injection system** and injection pump
- **Cam** *(regulates the timing of fuel injected)*
- **Injector valve/plunger** *(impacts injection pressure and injection rate)*
- **Piston** *(involved in compression ratio)*
- **Cylinder head** *(involved in compression ratio and mixing fuel/air)*
- **Air cooler** *(affects air and cylinder temperatures)*
- **Turbo charger** *(controls pressure and amount of inlet air)*

In general, a **slow-speed** engine (300 shaft rotation per minute, rpm) forms more NO_x than a **high-speed** engine (> 2,000 rpm).



Prolonged injector needle and adapted nozzle atomizer, on a Wärtsilä FAST fuel injector. Source: Wärtsilä

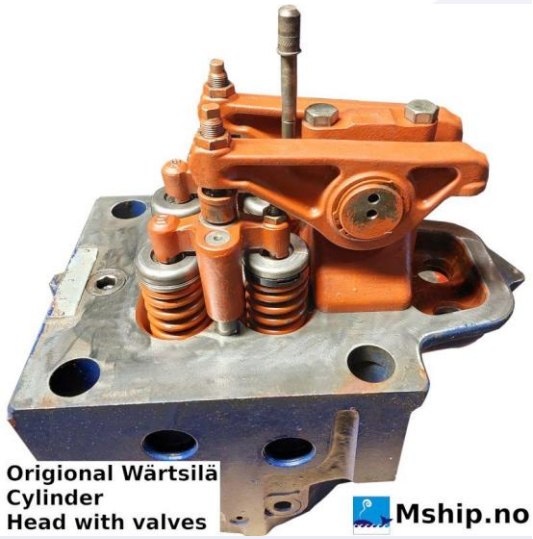


ABB Turbocharger

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Nitrogen Oxide NO_x
Regulation 13

Regulation 13– Nitrogen oxides NO_x

- NO_x emissions limits are based on:
  - ✓ the **diesel engine type (rotation per minute, rpm)**
  - ✓ the **ship construction date**
  - ✓ its **geographical area** of operation

- Compliance with Reg.13 controlled by a **Survey and certification** regime
  - ✓ issuance of **Engine International Air Pollution Prevention** (EIAPP) **Certificate**
  - ✓ subsequent **demonstration of in-service compliance** to NO_x limits
  - ✓ **NO_x Technical Code, 2008** sets the **framework for survey and certification**

- Parties to Annex VI may **introduce emission control areas** (ECA) for NO_x in designated geographical areas.

Regulation 13– Introduction

A complex regulation?

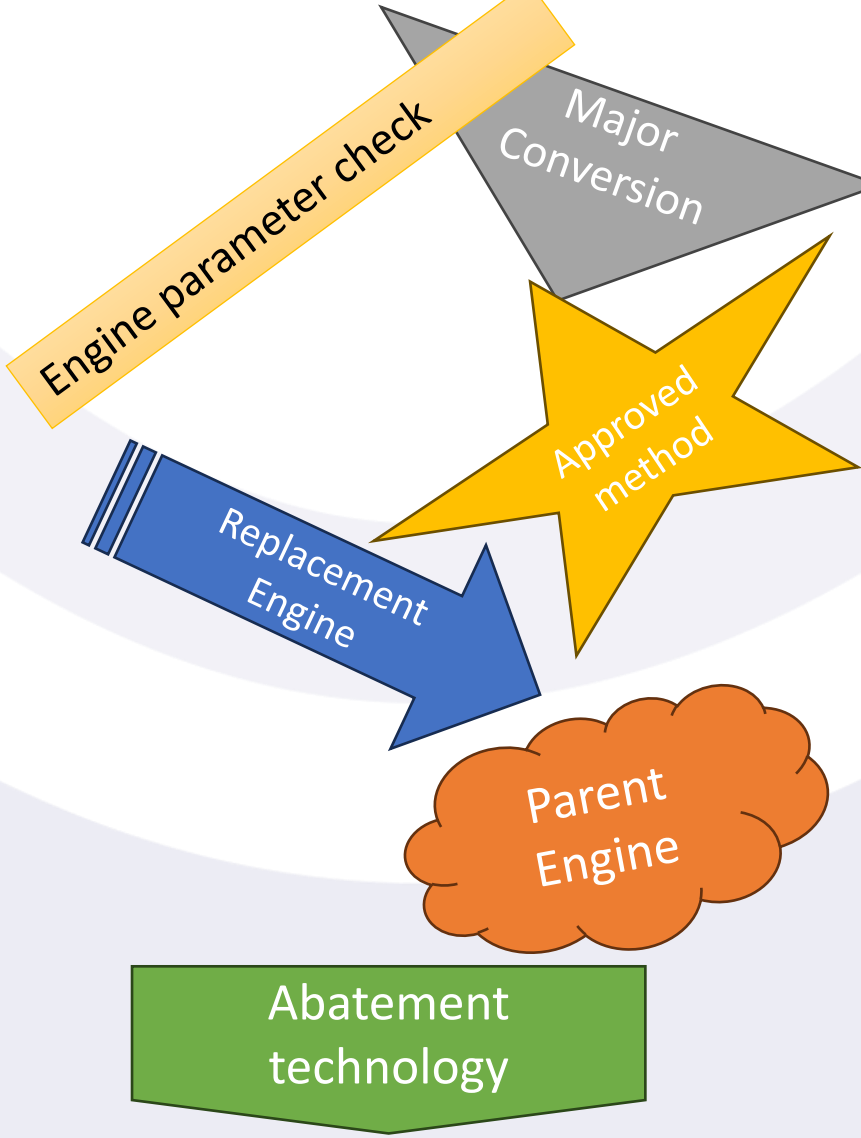
➢ Due to the wide array of technical terms and concepts…

A complex application?

➢ MARPOL Annex VI entered into force on **15 May 2005**.

➢ But the application date for **Tier I was set to 1 January 2000** (engines on ships with keels laid on or after 1/01/2000).

- This led to a "**retroactive application**" of the Tier I
- The industry and engine manufacturers **had anticipated** the change =
  - ***production of Tier I-compliant engines*** *was initiated in due time to ensure compliance.*
- The retroactive application of Tier I was also intended **for ships built prior to 2000** (with conditions).



Regulation 13 – Application scope

The NO_x limits apply to:

- **marine diesel engines**
- with an output power **over 130 kW**
- used for **propulsion** or **other services** onboard such as power generation.
  - ➢ ***Engines used solely for emergency purposes are excluded***
    - ➢ *emergency generators, emergency fire pumps, lifeboats' engines…*

- Definitions of "**installed**" and "**marine diesel engine**" in regs 2.12 and 2.14.

"Marine diesel engine" means any reciprocating internal combustion engine operating on liquid or dual fuel, to which reg. 13 applies, including booster/compound systems if applied. In addition, a gas-fuelled engine installed on a ship constructed > 1 March 2016 or a gas-fuelled additional or non-identical replacement engine installed on or after that date is also considered as a marine diesel engine."

Regulation 13 – Application of Tiers I, II and III

Tiers apply based on the **ship construction date**, with three "reference years":

- **2000** for Tier I
- **2011** for Tier II
- **2016** for Tier III (ECA)

Tiers I, II and III limits are set for **slow-speed**, **medium-speed** and **high-speed** engines.
For the most common range of engines (medium speed) the NO_x limit is calculated with the **engine's rated speed "n"** expressed as rotation per minute (rpm).

RPM	NOx calculated as total weighted emission of NO_2 (g/kWh)			Relative Reduction from Tier I
	< 130	130 ≤ n < 2000	≥ 2000	
Tier I	17.0	$45*n^{(-0.2)}$	9.8	0%
Tier II	14.4	$44*n^{(-0.23)}$	7.7	15.5% - 21.8%
Tier III	3.4	$9*n^{(-0.2)}$	2.0	80%

Regulation 13 – Tiers I, II and III

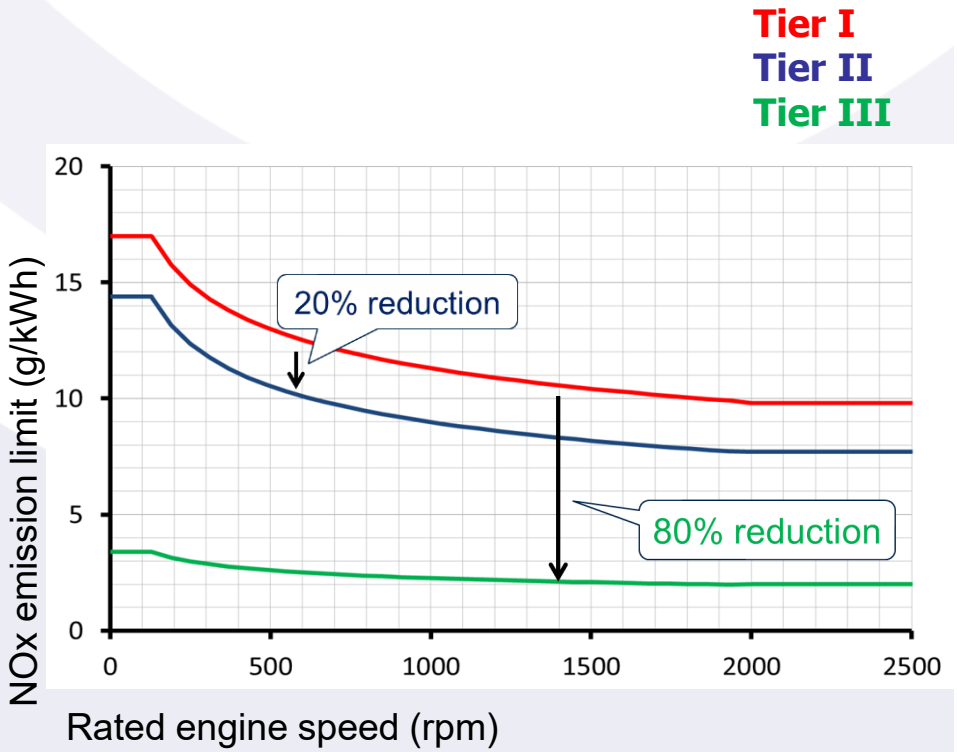
The difference between Tier I and Tier III is considerable: **80%** reduction of the emissions.

How to comply with Tiers?

- **Tier II limits** are met by **optimizing** the engine design, to alter the combustion process. Specific **engine parts or parameters can be modified** (FO injection system and associated timings and pressure, piston and cylinder head, scavenging air temperature and pressure, etc.).

- **Tier III limits** can only be met with the **additional use of NO_x reducing technologies**, as "adds-on" to a conventional engine, such as :
  - selective catalytic reduction **SCR** and exhaust gas recirculation **EGR**

  NB: appropriate **alternative fuels** (i.e. LNG) can be a solution



Regulation 13 – Major conversion

"**Major conversion**" is defined to ensure that the appropriate NO_x standards apply in case of **major changes to the engine or replacement after 1 January 2000**.

For a **major conversion** involving:

- **replacement** of a marine diesel engine with a **non-identical marine diesel engine**, or
- **installation** of an **additional marine diesel engine**

  ⇒ **the standards** at the time of the replacement or addition **of the engine** shall apply

In cases of **replacement** only, if the **replacement engine can not meet Tier III**

- the replacement engine may meet **Tier II** limits, **subject to acceptance by the Administration** + in line with **IMO Guidelines** on non-identical replacement engines not required to meet the Tier III limit

Tier II and Tier III were introduced in 2008 to strengthen the emission limits in light of technological improvements and implementation experience.
At that time, MEPC recognized that there could be cases where a replacement engine could not to meet the Tier II or III. IMO Guidelines were adopted to set criteria for such cases.

Regulation 13 – Exemptions

Image Credit: WorldWide Yachts

Exemption to Tier III standard in ECA for "smaller" ships

- **Ships specifically designed** and used **solely** for **recreational purposes,** with:
  - Length **< 24 m** or
  - Length **> 24** m but gross tonnage < 500, provided the ship was constructed before **1/01/2021**

This exemption intended to cover the **recreational, or pleasure, yachting industry**.
The **Tier III in ECA** was brought into effect for new larger yachts (L > 24 m) from **1 January 2021**.
*Nota bene! **yachts or pleasure vessels** used for commercial purposes **do not** benefit from this exemption.*

- Ship with a **combined nameplate diesel engine propulsion power < 750 kW** if it can be **demonstrated**, to the satisfaction of the Administration, that the ship can not comply because of **design or construction limitations**.
  - For ships fitted with "small" propulsion engines with design constraints (service vessels).

Regulation 13 – Exemptions

Exemptions in relation to shipyards and repair facilities – reg.13.5.4 and 13.5.5

Amico Shipyard Facilities, port of Genoa

A **temporarily exemption** may be granted for ships fitted with non-Tier III compliant marine diesel engines, **when those ships are built, converted, repaired and/or maintained in shipyards or repair facilities which happen to be located in a NOx Tier III ECA**.

Monaco Marine Shipyards, La Ciotat

This provision was necessary to **allow access to facilities deemed essential** for the shipping industry, when a zone is transitioning to Tier III.

Regulation 13 – Approved method

Approved methods for pre-2000 engines – regulations 13.7.1 to 13.7.5

When MARPOL Annex VI was originally adopted in 1997, it was agreed to:

- **apply retroactively the NO_x certification** to a specific range of **large engines** installed on ships constructed between **1990 and 2000**
- the "retroactive application scheme" affected only **large main engines on existing ships:**

Ships constructed between 1990 and 1999 were required to fit an "**approved method**" to enable the engine to meet **Tier I** limits (**modification of components** such as injectors/fuel nozzles, or optimized injection). IMO had to be notified of the approved method.

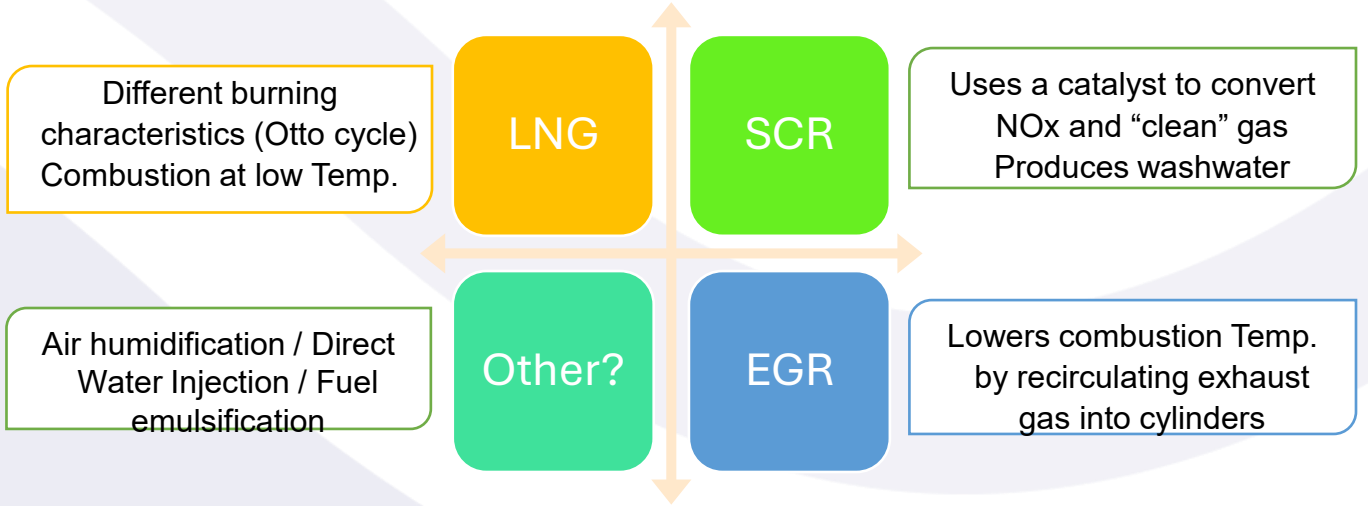
It may be considered that this **campaign of retroactive application has now ended**.
Today, ships built in the 1990's (ships > 25-year-old) have had ample time to retrofit approved methods developed by engine manufacturers and some of those ships might even have ceased service.

Regulation 13 – NO_x Tier III technologies

Different NO_x Tier III compliance options

NO_x Tier III standard = **80%** reduction in relation to Tier I limits.

- Altering, tuning or changing engine components **is not sufficient** to achieve compliance.
- Different technologies exist to further reduce NO_x emissions – aka **abatement** technologies.



- Selective Catalytic Reduction **SCR**
- Exhaust Gas Recirculation **EGR**
- Using **gas** **LNG/bioLNG** as fuel

- **Other** options but less developed

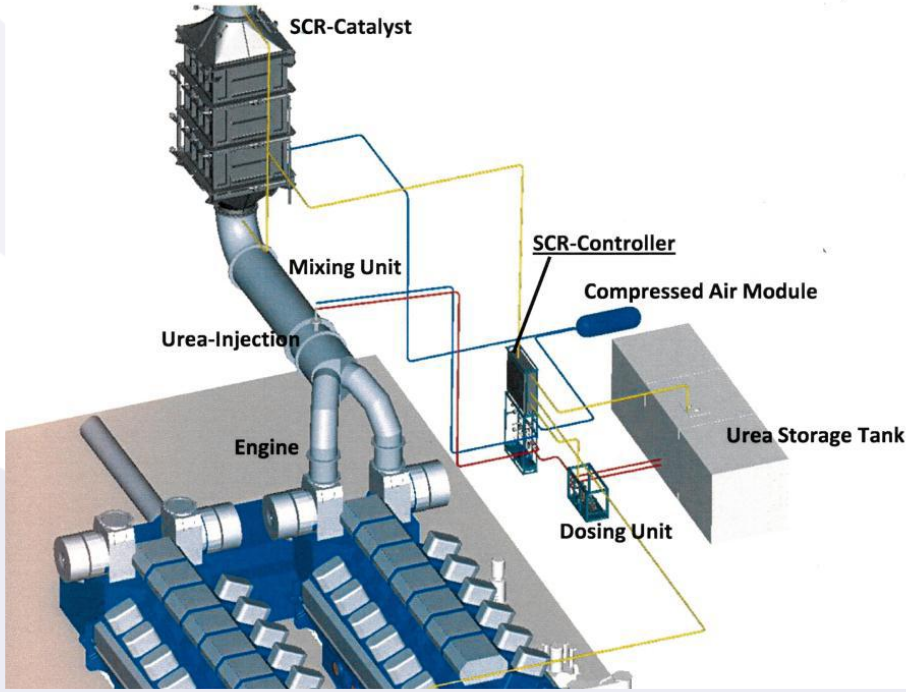
Regulation 13 – NO_x Tier III technologies

Selective Catalytic Reduction (SCR)

- A reducing agent is used to **treat** the exhaust gases:
  - **ammonia** in the form of urea solution
- The agent is injected and **mixed into the exhaust gas** stream, prior to entering in the SCR unit.
- Chemical reactions take place on the **catalyst**, as ammonia reacts with NO_x to produce nitrogen and water.

Urea for the SCR system is used in the form of aqueous solution = requires **urea tank on board**.

Source: ABS Advisory on NOx Tier III compliance



Source: MEPC 66/INF.4 Euromot

Regulation 13 – NO_x Tier III technologies

Exhaust Gas Recirculation (EGR)

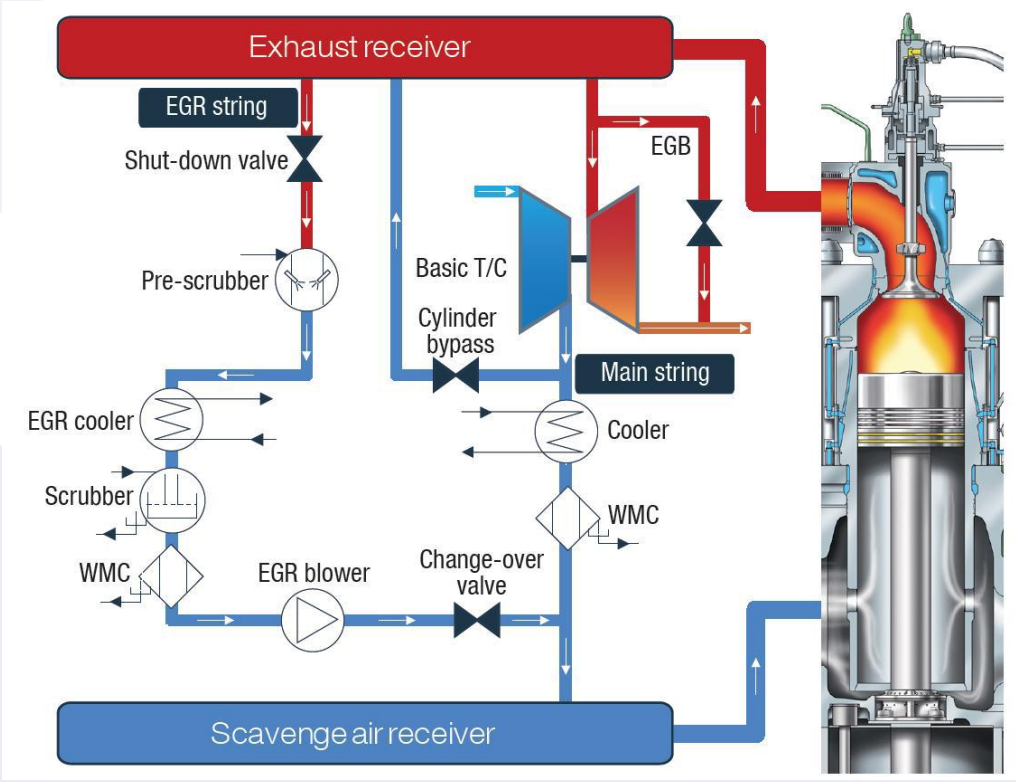
A portion of the **exhaust gases** (30-40%) is redirected to the **intake** side of the engine and **re-enters** the cylinders:

- recirculated exhaust gases ↓ O_2 and ↑ CO_2 in the incoming air
- peak **combustion temperature reduces** significantly
- **reduced NO_x formation**

Drawbacks of EGR:

- reduced combustion efficiency
- increased PM emissions

Recirculated gases need to be **cleaned** and **cooled** (by fresh water = washwater needs to be stored or treated).



Source: MEPC 66/INF.4 Euromot

Source: ABS Advisory on NOx Tier III compliance

Relevant IMO documents in relation to NO_x emissions

Complete and updated list available on IMO website “Index of MEPC Resolutions and Guidelines related to MARPOL Annex VI”
Here: https://www.imo.org/en/ourwork/environment/pages/index-of-mepc-resolutions-and-guidelines-related-to-marpol-annex-vi.aspx#1
An extract is given below.

Ref.	Name
MEPC.313(74)	2017 Guidelines addressing additional aspects to the NOx technical code 2008 with regard to particular requirements related to marine diesel engines fitted with selective catalytic reduction (SCR) systems
MEPC.1/Circ.854	Guidance on the application of regulation 13 of MARPOL Annex VI Tier III requirements to dual fuel and gas-fuelled engines
MEPC.272(69)	Amendments to the NOx Technical Code 2008 - (Testing of gas-fuelled and dual fuel engines)
MEPC.398(83)	Amendments to the NOx Technical Code 2008 (Certification of an engine subject to substantial modification or being certified to a Tier to which the engine was not certified at the time of its installation)
MEPC.307(73)	2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-Off Water
MEPC.399(83)	2025 Guidelines on Selective Catalytic Reduction (SCR) Systems

NO_x Technical Code

NO_x Technical Code

Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines
Abbreviated as NTC, 2008

- Originally adopted with the 1997 MARPOL Protocol (EIF 2005)
- Provides the framework for **survey and certification of marine diesel engines**
- **Application made mandatory** under regulations 5 and 13
- Largely **revised in 2008** and further amended afterwards

Latest amendments :

- **MEPC.398(83)** - Certification of an engine subject to substantial modification or being certified to a Tier to which the engine was not certified at the time of its installation – EIF 1 September 2026
- **MEPC.397(83)** - Use of multiple engine operational profiles for a marine diesel engine, including clarifying engine test cycles – EIF 1 March 2027

NTC, 2008 Table of content

Chapter 1 – General

Chapter 2 – Surveys and Certification

- Pre-certification
- Certification procedures
- Technical File and on-board verification
- Surveys and endorsements

Chapter 3 – Nitrogen Oxides Emission Standards

Chapter 4 – Approval for Serially Manufactured Engines: Engine **Family** & Engine **Group** Concepts

Chapter 5 – Procedures for NO_x Emission Measurements on a **Test Bed**

Chapter 6 – Procedures for Demonstrating Compliance with NO_x Emission Limits **On-board**

- **Technical File contents**
- Simplified Measurement method
- Direct Measurement & Monitoring method

Chapter 7 – Certification of an Existing Engine

Appendices -> Appendix 1 – Form of EIAPP Certificate

NO_x Technical Code

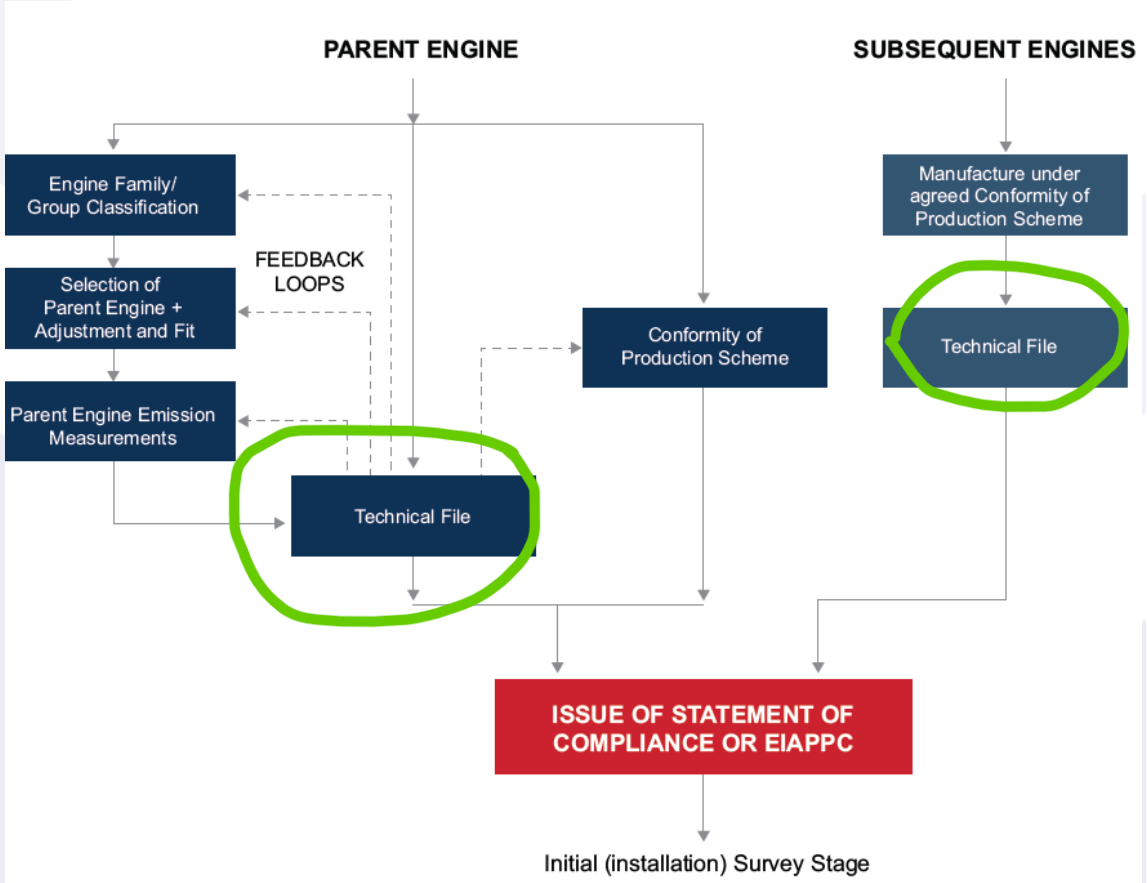
It sets the requirements for the **testing, survey and certification** of engines to ensure compliance with the NO_x Tiers.
Inspired from the series of **standards ISO 8178** on **Reciprocating internal combustion engines – exhaust emission measurement**.

Pre-certification

- Before their installation onboard, engines are subject to a **survey for pre-certification**, a process which is managed by **manufacturers**.
- Emissions are measured **on a test bed: test cycles** as described in the Code + appendix II of MARPOL Annex VI.

Different **pre-certification pathways** are available:

- **Each individual** engine is submitted to factory tests.
- **Engine Family** or **Engine Group** concepts:
  - series-produced engines that have identical design characteristics (Family) or similarities (Group)
  - **only** the **parent** engine is submitted to test-bed



Process for engine pre-certification under NTC.
Source: ABS Advisory on Tier III compliance

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NO_x Technical Code - Documentation

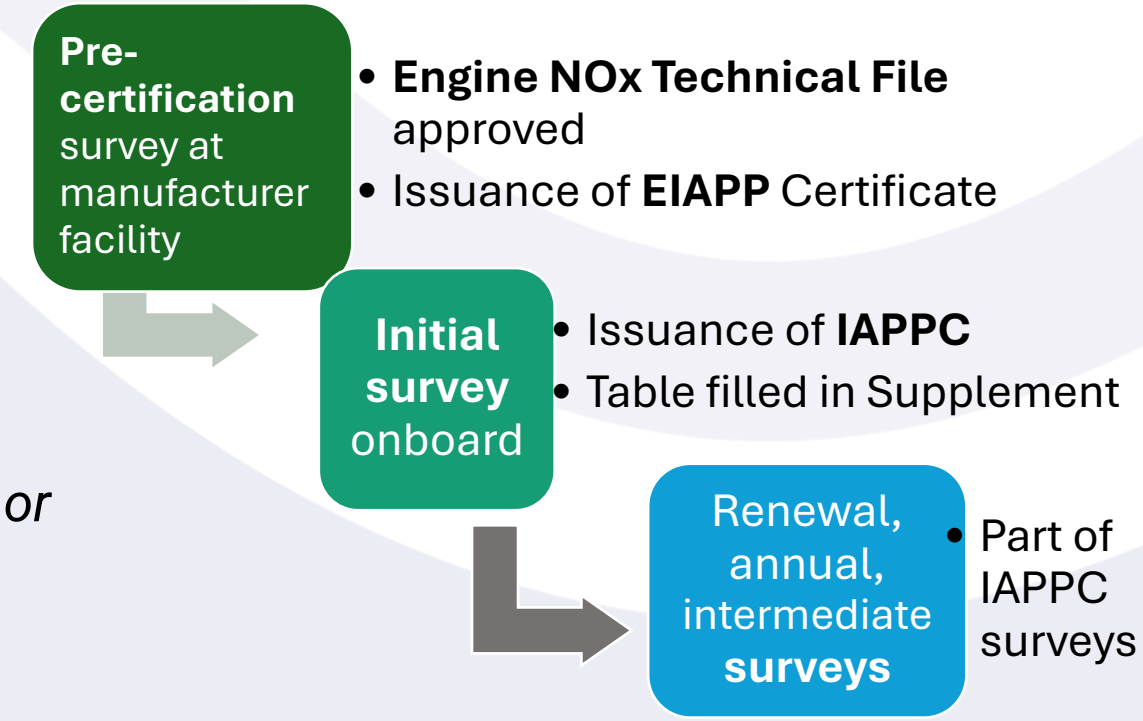
Each engine has its **NO_x Technical File:**

- information on components, settings, operating values
- **approved** by the Administration

Engine International Air Pollution Prevention (EIAPP) Certificate:

- issued **prior** to the engine installation onboard
- valid for the **entire life** of the engine
  - *unless the engine undergoes a major conversion or a substantial modification*

After installation onboard, the engine emission values are verified during **initial survey**.
The ship **IAPP Certificate** is then issued, its **Supplement** provides details on each engine.



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NTC, 2008

Chapter 5 (factory)

Chapter 6 (on board)

NTC, 2008 – Chapter 5
Procedures for NO_x emission measurements on a **test bed**

5.3 Test fuel oils

5.3.1 Fuel oil characteristics may influence the engine exhaust gas emission; in particular, some fuel-bound nitrogen can be converted to NO_x during combustion. Therefore, the characteristics of the fuel oil used for the test are to be determined and recorded. Where a reference fuel oil is used, the reference code or specifications and the analysis of the fuel oil shall be provided.

5.3.2 The selection of the fuel oil for the test depends on the purpose of the test. If a suitable reference fuel oil is not available, it is recommended to use a DM-grade (distillate) marine fuel specified in ISO 8217:2005, with properties suitable for the engine type. In case a DM-grade fuel oil is not available, an RM-grade (residual) fuel oil according to ISO 8217:2005 shall be used. The fuel oil shall be analysed for its composition of all components necessary for a clear specification and determination of DM or RM grade. The nitrogen content shall also be determined. The fuel oil used during the parent engine test shall be sampled during the test.

5.3.3 The fuel oil temperature shall be in accordance with the manufacturer's recommendations. The fuel oil temperature shall be measured at the inlet to the engine, or as specified by the manufacturer, and the temperature and location of measurement recorded.

5.3.4 The selection of gas fuel for testing depends on the aim of tests. In the case where an appropriate standard gas fuel is not available, other gas fuels shall be used with the approval of the Administration. A gas fuel sample shall be collected during the test of the parent engine. The gas fuel shall be analysed to give fuel composition and fuel specification.

5.12.4 NO_x correction for humidity and temperature

5.12.4.1 As the NO_x emission depends on ambient air conditions, the NO_x concentration shall be corrected for ambient air temperature and humidity with the factors in accordance with 5.12.4.5, 5.12.4.6 or 5.12.4.7 as applicable.

5.12.4.2 Other reference values for humidity instead of 10.71 g/kg at the reference temperature of 25°C shall not be used.

5.12.4.3 Other correction formulae may be used if they can be justified, validated and are approved by the Administration.

5.12.4.4 Water or steam injected into the charge air (air humidification) is considered an emission control device and shall therefore not be taken into account for humidity correction. Water that condensates in the charge cooler will change the humidity of the charge air and therefore shall be taken into account for humidity correction.

5.12.4.5 For compression ignition engines:

$$k_{hd} = \frac{1}{1 - 0.0182 \cdot (H_a - 10.71) + 0.0045 \cdot (T_a - 298)} \quad (16)$$

where:

T_a = the temperature of the air at the inlet to the air filter in K;

H_a = the humidity of the intake air at the inlet to the air filter in g water per kg dry air.

This presentation does not review in detail the content of Chapter 5. Extracts are provided to **illustrate** the level of technicity in the Code.

In practice, provisions of the NTC, 2008 are applied and "mastered" by **engine manufacturers and class societies**, as the stakeholders in charge of testing and surveys.

NO_x Technical Code – Chapter 6

Procedures for demonstrating compliance with NO_x emission limits <u>on board</u> – Measurement methods

After installation of a pre-certificated engine on board a ship, 2 types of onboard **surveys**:

- **Initial** survey (before the ship is placed into service)
- during the ship's life: as part for the renewal, annual/intermediate survey of the IAPP Certificate

3 methods to **demonstrate compliance with NO_x limits <u>onboard</u>**:

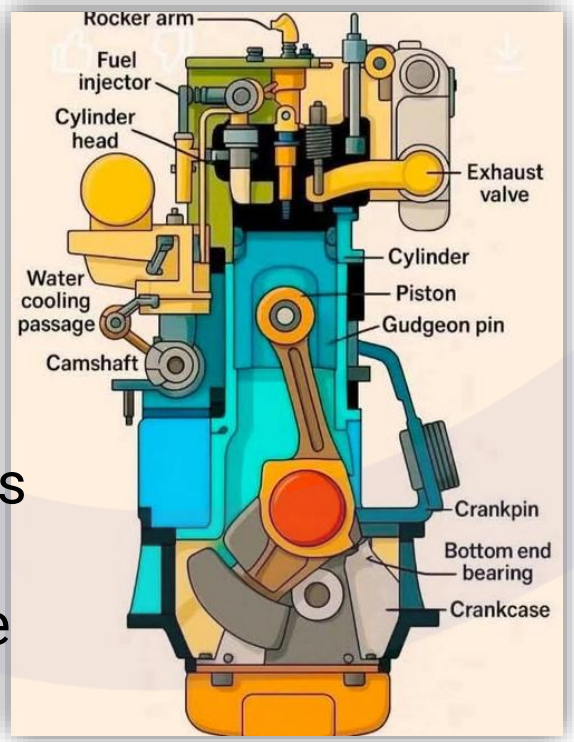
- **Engine parameter check**, focused on the engine NO_x Technical File: to verify that engine's components, settings and operating values **have not deviated** from the specifications in the File.
  - ✓ **This is the most commonly used method.**

- **Simplified measurement method**: a confirmation test onboard of NO_x as measured on the test bed.
  - ✓ more **complex** and expensive method
- **Direct measurement and monitoring**: a direct measurement of the engine exhaust flow.
  - ✓ measuring the gaseous flow might be complex to perform and prone to errors

NO_x Technical Code – Documentation

Engine Technical File

Each engine has its **NO_x Technical File** approved by the Administration.



- ❑ information on **components, settings, operating values** & adjustments to maintain NO_x emissions within allowable limits
- ❑ **method** chosen for **verification of compliance** (the 3 methods may be cited)
- ❑ **critical components** are identified (*injection nozzle, injection pump, camshaft, cylinder head, piston, connecting rod, charge air cooler and turbocharger*) – with an "IMO Reference number"
  - ✓ **Marked components can be easily identified** during surveys onboard the ship, when the "engine parameter check method" is applied.

NO_x Technical Code – Documentation

Record Book of Engine Parameters
For ships using the "engine parameter check method" as indicated in their Technical File, i.e. 99% of the fleet…
To record **all changes**, including like-for-like replacements, and **adjustments** within the approved ranges made to the engine's components and settings.

EIAPP
Engine IAPP **Certificate.** Valid for the entire life of the engine (unless…)

Ship IAPP Certificate <u>and its Supplement</u>
Issued after engine installation. Engine emission values are verified, and the **Supplement** is filled to provide details on each engine.

EIAPP (NTC 2008)

IAPP (MARPOL Annex VI)

SUPPLEMENT TO
ENGINE INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE
(EIAPP CERTIFICATE)

RECORD OF CONSTRUCTION, TECHNICAL FILE
AND MEANS OF VERIFICATION

Notes:

1 This Record and its attachments shall be permanently attached to the EIAPP Certificate. The EIAPP Certificate shall accompany the engine throughout its life and shall be available on board the ship at all times.

2 The Record shall be at least in English, French or Spanish. If an official language of the issuing country is also used, this shall prevail in case of a dispute or discrepancy.

3 Unless otherwise stated, regulations mentioned in this Record refer to regulations of Annex VI of the Convention and the requirements for an engine's technical file and means of verifications refer to mandatory requirements from the revised NO_x Technical Code 2008.

1 Particulars of the engine

1.1 Name and address of manufacturer .....

1.2 Place of engine build .....

1.3 Date of engine build .....

1.4 Place of pre-certification survey .....

1.5 Date of pre-certification survey .....

1.6 Engine type and model number .....

1.7 Engine serial number .....

1.8 If applicable, the engine is a parent engine ☐ or a member engine ☐ of the following engine family ☐ or engine group ☐ .....

1.9 Individual engine or engine family/engine group details:

1.9.1 Approval reference .....

1.9.2 Rated power (kW) and rated speed (rpm) values or ranges .....

1.9.3 Test cycle(s) .....

1.9.4 Parent engine(s) test fuel oil specification .....

1.9.5 Applicable NO_x emission limit (g/kWh), regulation 13.3, 13.4, or 13.5.1 (delete as appropriate) .....

1.9.6 Parent engine(s) emission value (g/kWh) .....

2 Particulars of the technical file

The technical file, as required by chapter 2 of the NO_x Technical Code 2008, is an essential part of the EIAPP Certificate and must always accompany an engine throughout its life and always be available on board a ship.

2.1 Technical file identification/approval number .....

2.2 Technical file approval date .....

3 Specifications for the onboard NO_x verification procedures

The specifications for the onboard NO_x verification procedures, as required by chapter 6 of the NO_x Technical Code 2008, are an essential part of the EIAPP Certificate and must always accompany an engine through its life and always be available on board a ship.

3.1 Engine parameter check method:

3.1.1 Identification/approval number .....

3.1.2 Approval date .....

Form of International Air Pollution Prevention (IAPP) Certificate

2.2 *Nitrogen oxides (NO_x)* (regulation 13)

2.2.1 The following marine diesel engines installed on this ship are in accordance with the requirements of regulation 13, as indicated:

	Applicable regulation of MARPOL Annex VI (NTC = NO_x Technical Code 2008) (AM = approved method)		Engine #1	Engine #2	Engine #3	Engine #4	Engine #5	Engine #6
1	Manufacturer and model							
2	Serial number							
3	Use (applicable application cycle(s) – NTC 3.2)							
4	Rated power (kW) (NTC 1.3.11)							
5	Rated speed (rpm) (NTC 1.3.12)							
6	Identical engine installed ≥ 1/1/2000 exempted by 13.1.1.2		☐	☐	☐	☐	☐	☐
7	Identical engine installation date (dd/mm/yyyy) as per 13.1.1.2							
8a	Major conversion (dd/mm/yyyy)	13.2.1.1 & 13.2.2						
8b		13.2.1.2 & 13.2.3						
8c		13.2.1.3 & 13.2.3						
9a	Tier I	13.3	☐	☐	☐	☐	☐	☐
9b		13.2.2	☐	☐	☐	☐	☐	☐
9c		13.2.3.1	☐	☐	☐	☐	☐	☐
9d		13.2.3.2	☐	☐	☐	☐	☐	☐
9e		13.7.1.2	☐	☐	☐	☐	☐	☐
10a	Tier II	13.4	☐	☐	☐	☐	☐	☐
10b		13.2.2	☐	☐	☐	☐	☐	☐
10c		13.2.2 (Tier III not possible)	☐	☐	☐	☐	☐	☐
10d		13.2.3.2	☐	☐	☐	☐	☐	☐
10e		13.5.2 (Exemptions)	☐	☐	☐	☐	☐	☐
10f		13.7.1.2	☐	☐	☐	☐	☐	☐

NO_x Technical Code – NO_x-reducing devices

Pre-certification of engine systems fitted with NO_x-reducing devices

Exhaust gas recirculation

An engine equipped with EGR will be pre-certified **as a single unit**; no specific regulations for EGR. Its components are recorded in the Technical file.

Selective Catalytic Reduction

A SCR system is typically manufactured and supplied **separately** from the engine.
Specific procedures for pre-certification of engines fitted with SCR are detailed in MEPC Guidelines, with **2 options** available:

- **Scheme A**: **combined** engine and SCR system, as one unit, is subject to pre-certification test-bed
- **Scheme B**: SCR **cannot be tested with engine** on test-bed. Onboard **confirmation tests** done as part of initial survey

Retroffiting a SCR on an existing engine

Ships may need to be Tier III-compliant (ships built after ECA EIF), due to **changes of operational plan** and entry in NO_x ECA. Certification is required, different approaches can be applied. Ideally the engine manufacturer is engaged for retrofitting the SCR unit and acts as the applicant for the Tier III certification (under Scheme B). Refer to Guidelines MEPC. 291(71)

NO_x Technical Code – Engine Technical File and PSC

Importance of the Engine Technical file (and the Record Book of Engine parameters)

It provides the **basis for verification of compliance**, in particular during PSC inspections.
NTC, 2008 recalls the general principle of **undue delay**

> *As a general principle, onboard NO_x verification procedures shall enable a surveyor to **easily determine** if an engine has remained in compliance with reg.13. (…) It shall **not be so burdensome** as to **unduly delay the ship** or to **require in-depth knowledge of the characteristics** of a particular engine or specialist measuring devices not available on board.*

- The **NOx Technical File** for **main engine and generators** shall always be available onboard ships.
- The **Record Book of Engine Parameters** shall be properly filled in
  - information on maintenance and replacement of components (when the "engine parameter check method" is used, i.e. for most ships).
- Engine parts shall bear an **IMO identification number** as per the engine Technical File.

The engine NO_x Technical File is also a **cornerstone of the framework** "Energy efficiency and carbon intensity of ships", i.e. Chapter 4 of MARPOL Annex VI (as it lists and details all parameters impacting exhaust gases).

Sulphur oxides emissions and Particulate matter
Regulation 14

Regulation 14 – Sulphur oxides SO_x and PM

The 2008 amendments to MARPOL Annex VI had introduced **global sulphur limits for marine fuel oils**:

- 4.50% m/m prior to 1 January 2012
- 3.50% m/m on and after 1 January 2012
- **0.50%** m/m on and after **1 January 2020**

The 0.50% limit, known as "IMO 2020", became the global sulphur limit in 2020.
1 March 2020: carriage ban of non-compliant fuel oil introduced (for propulsion or operation on board ships + unless the ship has an **approved equivalent method of compliance =** scrubber/EGCS).

The previous sulphur limits were **removed from the regulation text**, which now simply reads:
"sulphur content of fuel oil used or carried for use on board a ship shall not exceed 0.50 m/m."

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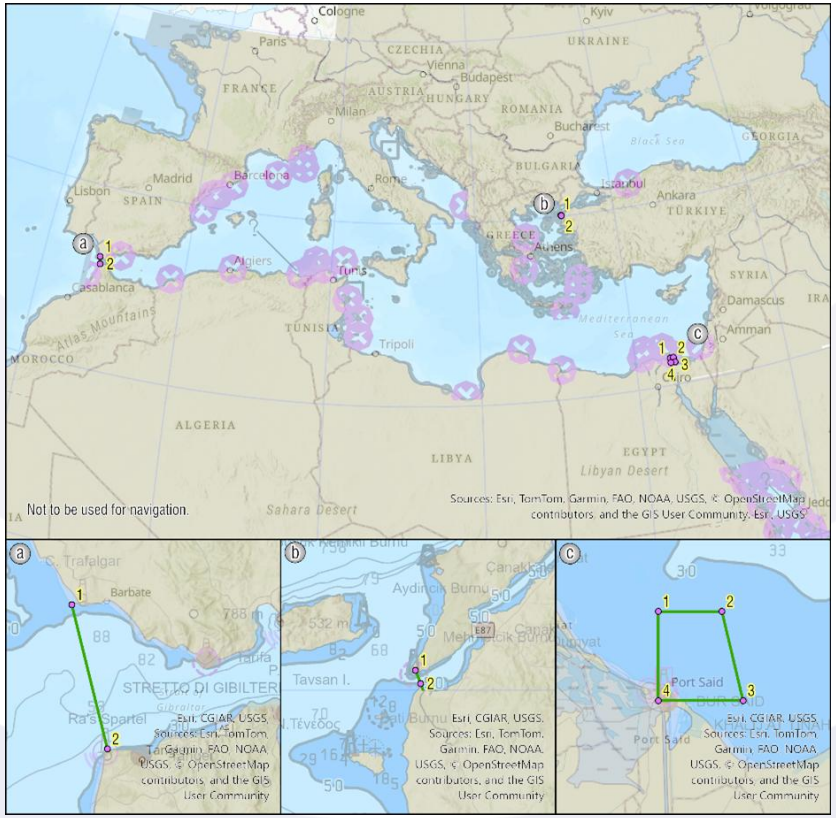
Regulation 14 –Emission control areas

Regulations 14.3 to 14.5

Parties to MARPOL Annex VI may submit proposals to the MEPC for the **designation of emission control areas** for SO_x and PM.
Criteria and procedures in **appendix III** to MARPOL Annex VI.

- **Med ECA**: introduced by Resolution MEPC.361(79)
  - prohibits ships operating within the area from using FO with a sulphur content > 0.10% m/m
  - unless an approved equivalent arrangement (EGCS) is used
- 5th area worldwide to be designated as an ECA for SO_x and PM



Mediterranean Sea SOx ECA – source: Llyod's Register

Regulation 14 – **Other aspects**

- The worldwide **average sulphur content of residual fuel oil** supplied for use on board ships is monitored by IMO Secretariat.
- The results of the sulphur monitoring campaigns are **presented** every year to MEPC.

Results obtained in **2023**

Yearly worldwide average sulphur contents of fuel oils and three-year rolling averages

Year	Document Reference	Average yearly sulphur content in each category			Three-year rolling average sulphur content in each category		
		≤ 0.10%	> 0.10 to ≤ 0.50%	> 0.50%	≤ 0.10%	> 0.10 to ≤ 0.50	> 0.50
2021	MEPC 78/INF.4	0.07	0.45	2.70			
2022	MEPC 80/INF.4	0.06	0.46	2.73	0.06	0.45	2.70
2023	MEPC 82/INF.2	0.06	0.45	2.67			

Extract of the report on the sulphur monitoring programme (MEPC 80/INF.4).

Fuel oil availability and quality
Regulation 18

Regulation 18 – Fuel oil availability and quality

Fuel oil availability

- Parties to **promote availability** of compliant fuel oils
- Ships **should not be required to deviate** or delay unduly the voyage to achieve compliance

Fuel oil non-availability FONAR – Reg. 18.2

In case on non-compliance, when a ship cannot purchase appropriate fuel oil, operators shall:

- ✓ **Submit a FONAR**
- ✓ **Notify** Flag State and Port State

- A fuel oil non-availability report is not an exemption.

The FONAR intends to capture information on:

- **Attempt** to obtain compliant fuel / Non-availability of fuel
- Attempt to find alternative sources of compliant fuel / Everything else to demonstrate best intentions

Regulation 18 – FO availability and quality

Fuel oil quality (reg. 18.3)
Different types of requirements:

- ❑ **For FO suppliers**:
  - **Properties** of FO delivered
  - **Bunker Delivery Note**
  - Bunker **sampling** procedure (MARPOL sample)
- ❑ **For Port States**
  - Maintain a **register** of local FO suppliers
  - **Take action against** local FO suppliers in case of non compliance with info stated on BDN
- ❑ **For all parties**:
  - **Sampling and verification procedures**: refer to appendix VI of Annex VI + MEPC Guidelines

Ozone Depleting Substances (ODS) Regulation 12

Regulation 12 - Ozone-Depleting Substances

ODS are defined in regulation 1.25:

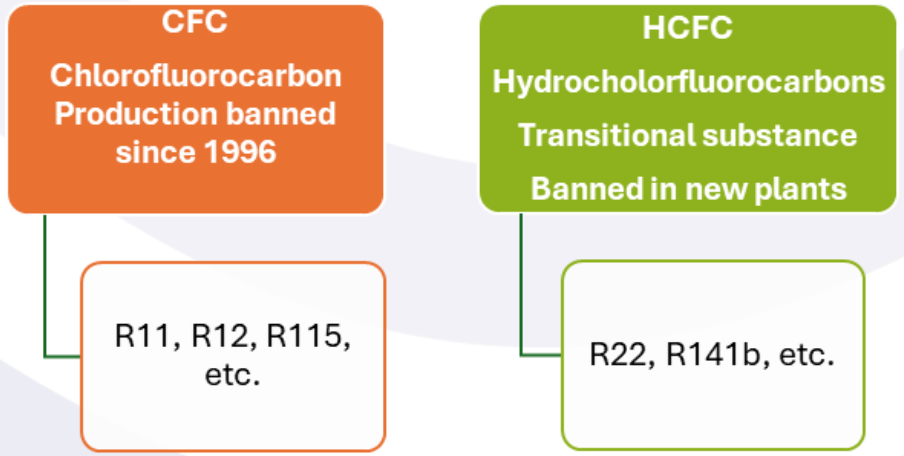
the substances controlled internationally under the Montreal Protocol and listed in its Annexes A, B, C or E

ODS typically found onboard include:

- **CFCs**
- **HCFCs**, introduced as an intermediate replacement for CFCs

The production and use of all these substances is being phased out under the **Montreal Protocol** (1989).

NB: Reg.12 does not apply to permanently sealed units without refrigerant charging connections.



System or equipment containing	Installation prohibited on new and existing ships
CFCs	since 19 May 2005
HCFCs	since 1 January 2020

Regulation 12 – Ozone Depleting Substances

Delivery to appropriate reception facilities

When **servicing or decommissioning** systems containing ODSs, the gases are **collected in a controlled manner** and, if not to be reused on board, **landed to appropriate reception facilities for banking or destruction.**
Also applies when a ship is dismantled at the end of service.

Documentation

Ships with an IAPP Certificate (> 400 GT), platforms or drilling rigs engaged in international voyages, shall:

- maintain the list of equipment containing ODS: **Record of Equipment** attached to IAPP
- maintain a **record book for rechargeable systems** containing ODS: operations related to recharge, repair or maintenance of the systems, discharge (deliberate or not).

Volatile Organic Compounds (VOC) Regulation 15

Regulation 15 – Volatile organic compounds (VOC)

Volatile organic compounds are the l**ighter parts of crude oil, or their products, carried by tankers**. They normally **vaporise in the tanks during the ship loading process** and could be vented to the atmosphere, causing air pollution in port areas.

2 types of provisions in regulation 15:

- for **State Parties:** implementation of VOC control measures in ports
- for **tankers** (oil tankers and/or chemical tankers; gas carriers with conditions)

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Picture Credit: ICS / ISGOTT

Regulation 15 – Volatile organic compounds

Parties may implement **VOC control measures for tankers** (oil tankers or chemical carriers) **in their ports and terminals**.
Tankers visiting such ports shall be **fitted with a vapour emissions control system (VECS)**.

- list of such ports and terminals available on GISIS

Vapour emissions control system VECS

Both the **shipboard VECS and the shore arrangements** shall be designed and operated based on the safety standards developed by IMO.
The shipboard vapour emissions collection system is **approved** by the flag Administration.

Figure 2.2 – Main Cargo Deck of a Crude Oil Tanker

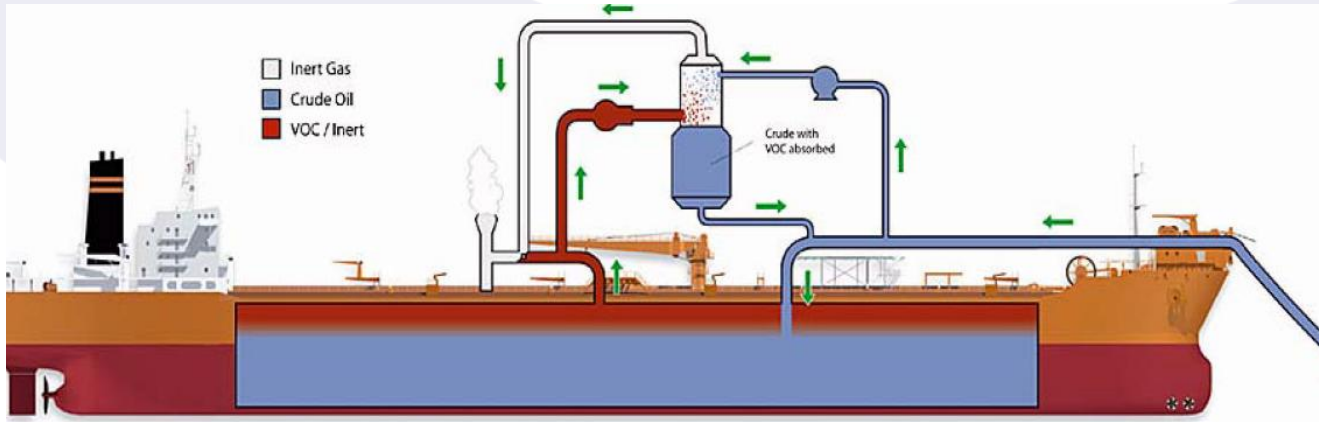
Source: MEPC.1/Circ.680

Regulation 15 – VOC management plan

The second part of reg. 15 covers **VOC management plan.** It has no link with the fact that ports regulate, or not, VOC emissions.

VOC management plan for tankers carrying crude oil:

- developed **specifically** for the ship, based on IMO guidelines
- **approved** by the flag Administration
- to prevent emissions by optimizing **operational procedures** and/or by using of devices. VOCs generated by **crude oil washing** shall also be considered.



Example of a Vapour Recovery System to control VOC. Source: MEPC.1/Circ.680

Shipboard Incineration
Regulation 16

Regulation 16 – Shipboard Incineration

This regulation is two-fold:

1 - type-approval and certification of incinerators
2 - operational requirements for incineration onboard all ships

Incinerators on ships built > 1 January 2000 or installed **> 2000**:

- shall be **Type Approved**
- have a manufacturer's **operating manual**
- achieve a **combustion chamber temp. of 600°C** within 5 min
- fitted with a combustion flue gas outlet **temperature monitoring system**

Personnel shall be **trained** in its use.

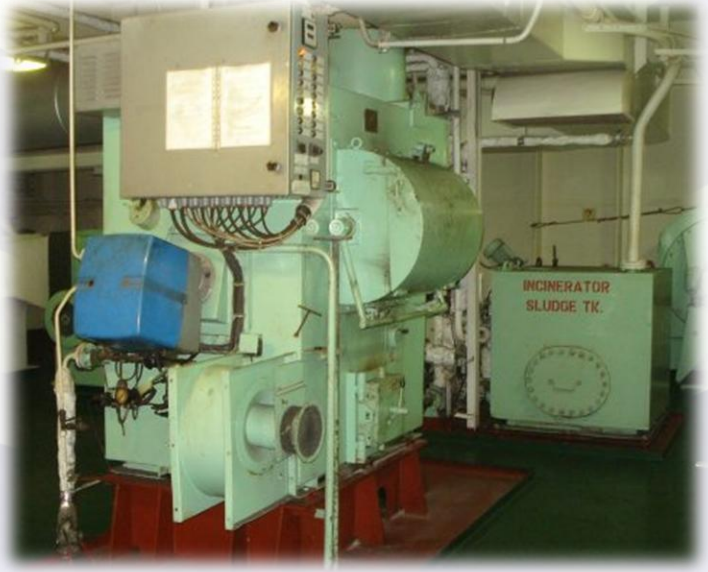


Image credit: Maritime Education

Regulation 16 – Shipboard Incineration

It is **prohibited** to incinerate specific substances or waste:

- MARPOL Annex I, II & III cargoes
- Polychlorinated biphenyls (PCB)
- Garbage containing **heavy metals**
- Refined petroleum products containing **halogens**
- Sewage and sludge oil **not generated on board**
- **Exhaust gas cleaning system** residues

It is **permitted** to incinerate:

- PVC – plastics (**if incinerator is type approved to do so,** which is almost always the case)
- **Sewage sludge and sludge oil** generated during normal operation permitted in main or auxiliary power plant or boilers **but not when in ports, harbours and estuaries**

Reception Facilities
Regulation 17

Regulation 17 – Reception Facilities

Out of the 6 MARPOL Annexes, 5 have regulations **requiring the provision of reception facilities**:

*"Each Party undertakes to ensure the provision of **facilities adequate** to **meet the needs of ships** using their ports or terminals,… without causing undue delay…".*

The provision of reception facilities in ports is crucial for effective MARPOL implementation. It does not mean that the Government itself shall provide the facility.

- Port authorities or terminal operators may take the role of **service provider**.

The "**needs of ships**" means that reception facilities shall be available for ships to dispose of:

- **ozone-depleting substances** (equipment and materials containing ODS, such as insulation foams) in repair ports and ship-breaking facilities; and
- **residues** from EGCS (SO_x scrubber)

Regulation 17 – Reception Facilities

A crucial regulation, which was modified as it was seen as a **major hurdle to overcome for some States to achieve full compliance with MARPOL**.

2006

- the policy of "*zero tolerance of illegal discharges from ships*" could only be effectively enforced if there are **adequate reception facilities in ports.**
- all Parties to MARPOL, particularly port States, shall fulfil their **treaty obligations** and provide **reception facilities for wastes** generated during the normal operation of ships.
- **Standards documents**: Advance Notification Form / Waste Delivery Notification form: provide uniformity of records throughout the world.

2012

- amendments to MARPOL: **Small Island Developing States** (SIDS) may satisfy the relevant requirements of reception facilities through **regional arrangements** when, because of those States' unique circumstances, such arrangements **are the only practical means** to satisfy these requirements.

Regulation 17 – Reception Facilities

- Ships/Flag State report **unavailability or alleged inadequacies of facilities** (on GISIS, validated by IMO).
- When Reception Facilitates are not available, ship should ensure sufficient **storage** for ODS and EGCS residues.
- If an EGCS is installed, owners should consider onboard storage space requirements.

Information on reception facilities is available on

MARPOL Annex VI Chapter 4

Overview and expectations

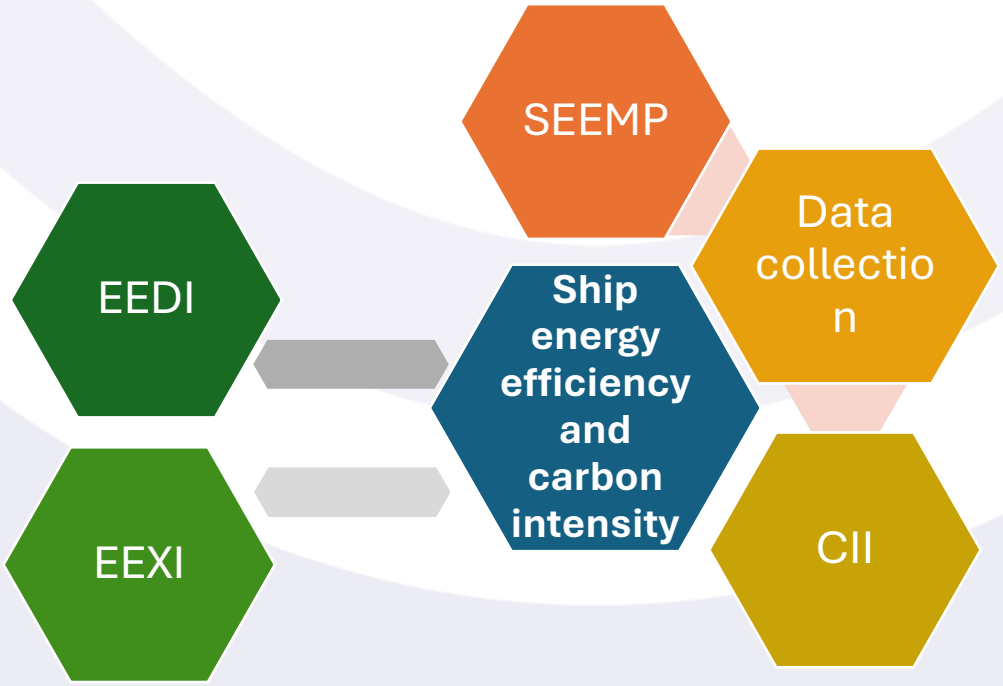
Chapter 4 - Regulations on the carbon intensity of international shipping

Chapter 4 was extensively modified as part of the **2021 revision** of MARPOL Annex VI.

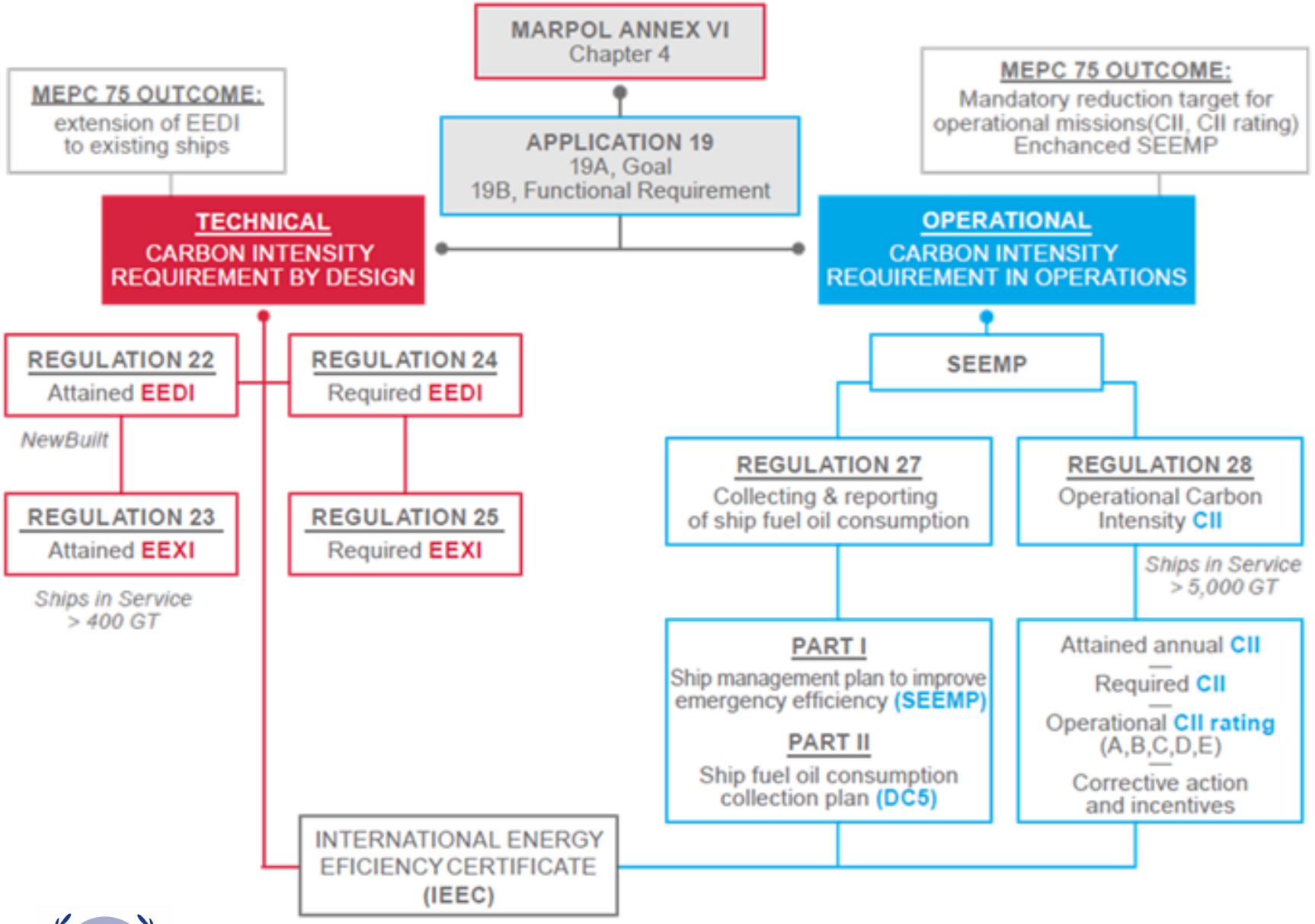
Developed under the framework of the *Initial IMO Strategy on Reduction of GHG Emissions from Ships* agreed in 2018, new technical and operational amendments entered into force on 1 November 2022, in effect on 1 January **2023**:

- Energy Efficiency Existing Ship Index **EEXI**
- annual operational carbon intensity indicator **CII** and CII rating

Existing regulations on the Energy Efficiency Design Index (EEDI), the Ship Energy Efficient Management Plan (SEEMP) and the data collection system (DCS) were also modified.



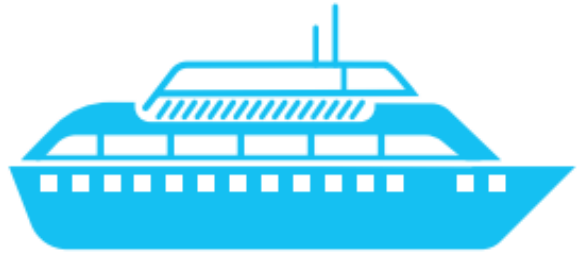
Chapter 4
An overview



Source: Bureau Veritas

EEDI

ENERGY EFFICIENCY DESIGN INDEX IMPROVING THE TECHNICAL PERFORMANCE OF NEW BUILD SHIPS



1

Ships which are **designed and constructed today** must be **MORE ENERGY EFFICIENT** than the baseline, thus reducing their carbon intensity

2

Performance targets are increasingly stringent over time, thus **INCENTIVIZING INNOVATION** in ship design

3

There are **DIFFERENT GOALS FOR DIFFERENT TYPES OF SHIPS,** recognizing the specificities of different types of ships

4

For example, **THE LARGEST CONTAINER SHIPS (>200,000 DWT)** built after 1 April 2022 **must be 50% more efficient** than the baseline

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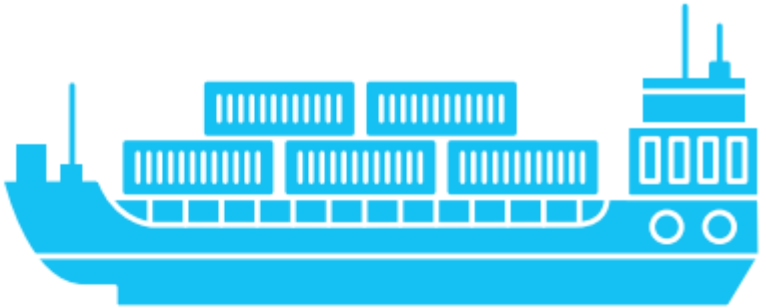
Chapter 4

EEXI

ENERGY EFFICIENCY EXISTING SHIPS INDEX IMPROVING THE TECHNICAL PERFORMANCE OF EXISTING SHIPS



1

The requirements for EEXI certification **ENTERED INTO FORCE on 1 November 2022**

2

All ships are required to calculate their **Attained Energy Efficiency EXISTING SHIP INDEX (EEXI)**

3

The EEXI is a **ONE-TIME CERTIFICATION** for existing ships targeting design parameters

4

There are a variety of technical means to **IMPROVE THE CARBON INTENSITY** of existing ships and **achieve the Required EEXI**

5

A review clause requires IMO to REVIEW THE EFFECTIVENESS of the implementation of the EEXI requirements, by 1 January 2026 at the latest, and, if necessary, **develop and adopt further amendments**

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CARBON INTENSITY INDICATOR (CII RATING)

IMPROVING THE OPERATIONAL PERFORMANCE OF EXISTING SHIPS

1

Each year, ships of 5,000 gross tonnage and above **collect and report fuel consumption data.**
On the basis of this data,
A CARBON INTENSITY RATING IS ASSIGNED TO THE SHIP, FROM A TO E

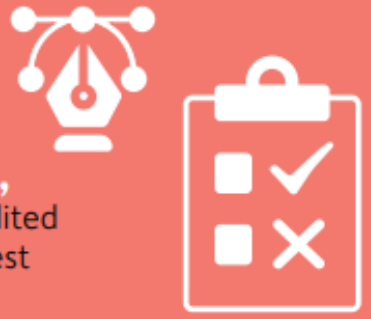
2

There are a variety of operational means to
IMPROVE THE CARBON INTENSITY OF EXISTING SHIPS
and achieve the Required CII, e.g.:

- Ship speed optimization
- Weather routing
- Just-in-time arrival
- Trim, draft, and ballast optimization

3

Poorly rated ships
have to implement
A PLAN OF CORRECTIVE ACTIONS,
and the company is regularly audited incentives may be provided to best rated (A/B) ships



4

The requirements
for CII rating
ENTERED INTO EFFECT
on 1 January 2023

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End of
Agenda Item 3: Overview of MARPOL Annex VI & NO_x Technical Code - Part 2

Now, agenda Item 4

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November 2025