Masterclass Emission Control Area

Regulation Information / Costs and Compliance / FAQs / References

Sustainable Ships

SUSTAINABILITY ON DEMAND

EXECUTIVE SUMMARY

This masterclass provides a comprehensive overview of IMO's Emission Control Areas (ECAs), the regulations involved for SO_x Emission Control Areas (SECAs) and NO_x (NECAs), for both existing and expected ECA zones. Furthermore, information on compliance to these regulations and cost implications for several mitigation options are discussed. The purpose of this document is to provide a copy of all existing information on the Sustainable Ships platform, including referenced sources, PDFs and more. Contact the helpdesk at any time for assistance.

Use the Decarbonizer to quickly estimate retrofit costs for your vessel.

Liability Disclaimer

Sustainable Ships will not be held responsible for any damages that could arise from using the information provided in this report or on its platform. All costs provided in this blogs are estimated, based on anecdotal evidence from research. All numbers are indicatory only. View all terms and conditions here.

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1.0 ABOUT ECAS

An Emission Control Area (ECA) is a sea area in which strict controls to minimize airborne emissions from ships are established. Initially this regulation was aimed to reduce sulphur oxides (SO_X). It was extended in 2005 to include nitrogen oxides (NO_X) for several areas. ECAs with restrictions on SO_X only are also referred to as SECAs. ECAs with restrictions on NO_X are also referred to as NECAs[1].

The rules are part of the International Convention for the Prevention of Pollution form ships (MARPOL) Annex VI (Regulations for the Prevention of Air Pollution from Ships). More specifically these are regulation 13 and 14, which cover Nitrogen Oxides (NO_x) and Sulphur Oxides (SO_x) and Particulate Matter (PM) emissions of ships.

There are ‘four’ existing ECAs: the Baltic Sea, the North Sea, the North American seas, including most of US and Canadian coast and the US Caribbean. For the exact coordinates, click here. The Mediterranean will be included as ECA in 2025. Several countries, including China, South-Korea and Australia have already nominated their territorial waters to be part of the ECAs.

Figure 1. Current ECAs around the world. It should be noted that the Mediterranean ECA comes into effect as per 2025. Others are not yet official.

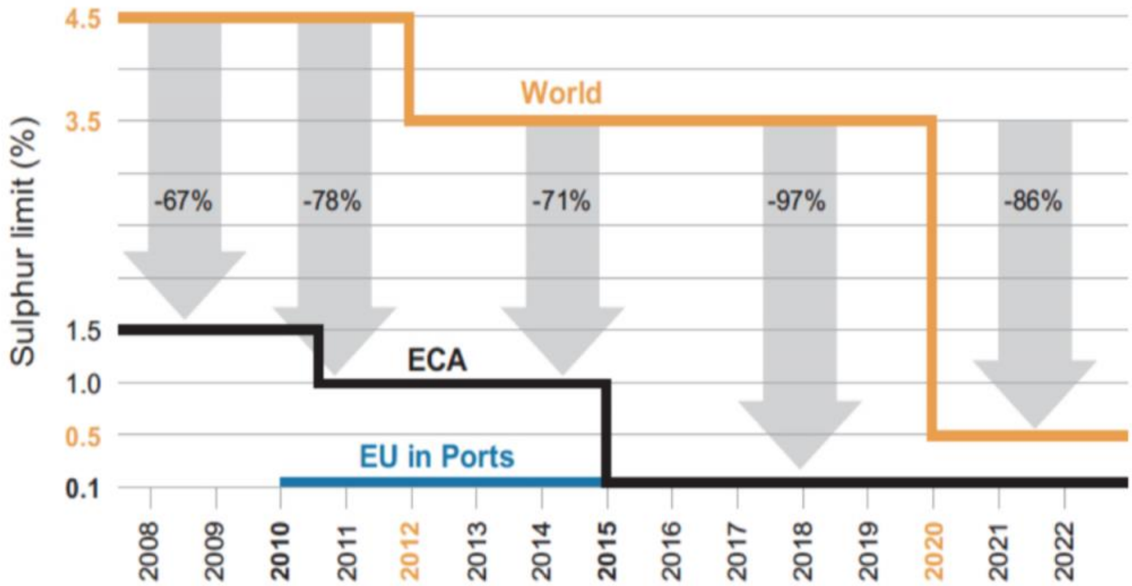
[1] For the sake of clarity and specificity, these terms are adhered to unless regulations apply to both a SECA and a NECA, in which case simply ECA is used.

2.0 SECA – SULPHUR EMISSION CONTROL AREA

SECA		
Organization	IMO	
Area	North Sea, US East, Westcoast and Caribbean, Baltic, Mediterranean (2025), Japan (proposed), South-Korea (proposed), China (proposed), Australia (proposed)	
Effective Date	2011	
Keywords	Operational Restriction, Emissions, SO_X	
More information	www.sustainable-ships.org/rules-regulations/eca	
Source	IMO	
Contact	MARPOL – Contacts per flag state MEPC.6/Circ.20 – Operational contacts per flag state	
Status	Active	
Applicable to	All ships	
Cost Impact	Moderate	+20% fuel cost or €300.000+ per MW for scrubber
Time Impact	Negligible	-

2.1 Introduction

Ships sailing in Emission Control Areas will have to use fuel oil on board with a sulphur content of no more than 0.10% (mass by mass). Hence these are referred to as SECAs. The interpretation of "fuel oil used on board" includes use in main and auxiliary engines and boilers. Outside SECAs the maximum allowable sulphur content of fuel is 0.50%. The below figure shows an historic overview of the implementation of maximum allowable sulphur limit in SECAs, EU Ports and worldwide.



2.2 How to comply

The below options may be considered to comply with regulations. Guidelines intended for use by Administrations, port States, shipowners, shipbuilders and fuel oil suppliers have been provided in MEPC.320(74).

Multi-fuel

The most common option for most shipowners at the moment, is to have two or more separate fuels on board. These could be low-sulphur and high-sulphur fuels (with a maximum of 0.50% sulphur content) or even marine diesel oils as opposed to heavy fuel oils. Fuel options are of course limited by the engine design and should be discussed with the chief engineer and Original Engine Manufacturer (OEM) if needed.

Change fuel

Alternatively one can switch to LNG as marine fuel as sulphur content of LNG is virtually zero. This will have a severe cost impact and is generally not recommended for refits, but a larger number of newbuilds destined for international voyage will be using LNG (roughly 30% at the time of writing). An advantage of using LNG is that compliance to NO_x limits will be easier. A disadvantage is that IMO rules and regulations for low-flashpoint fuels will apply.

SO_x scrubber

Alternatively an aftertreatment system can be installed to remove the sulphur from the exhaust gas. This can be done with open-loop scrubbers or closed-loop scrubbers. Open-loop systems simply remove the SO_x from the exhaust gas and insert it into the seawater. Closed-loop systems will store the SO_x sludge, after which it has to be handled when in port. Specific IMO regulations apply as described by the 2015 guidelines for exhaust gas cleaning, resolution MEPC.259(68).

2.3 Cost impact

The below sections provide an indication of the costs for the use of different fuels, retrofitting to LNG and the installation of a scrubber.

Multi-fuel

As a rule of thumb, price differences between more expensive low-sulphur fuel oil (VLSFO) and cheaper high-sulphur fuel oil (HSFO) are $100 in the past two years approximately. Given these price ranges and the absolute costs of fuel, using a low-sulphur fuel incurs a fuel premium of roughly 20%. This would only apply *when using low-sulphur fuel* of course, mostly only used in SECAs.

In 2021, the price difference ended at $153 per tonne, as opposed to $80 in early 2021. The average price difference in 2021 was $112 per tonne compared to $92 per tonne in 2020. In 2021, the average price on VLSFO was $544 per tonne. In comparison, the average price on HSFO increased by to $433 per tonne.

Change fuel

Retrofits to LNG are prohibitively expensive and usually not feasible for many ship types, as the IMO regulations for low flashpoint fuels dictate serious technical, operational and safety constraints. In addition to engine changeover, all fuel tanks and piping has to be redesigned and installed. As such, LNG refits are commonly only considered for (very) large vessels only, operating in ECAs or for high-demanding clients.

That being said, as a rule of thumb from market experience, retrofitting a large (LNG-ready vessel) would already costs around $35M. This is pure CAPEX costs and excludes OPEX. Given these figures, it is generally not recommended to change fuel to LNG for SECAs only. Only other, more demanding restrictions would validate such an endeavour.

SO_x scrubber

The capital cost (CAPEX) of scrubbers is currently high at between $500k to $5M depending upon maker and vessel. The time for a retrofit is currently more than a typical scheduled drydocking meaning that extra lost earning days add to the CAPEX.

2.4 How to demonstrate compliance

Flag States must issue an International Air Pollution Prevention (IAPP) Certificate to the ship. This includes a section to state that the ship uses fuel oil with a sulphur content that does not exceed the applicable limit value as documented by bunker delivery notes; or uses an approved equivalent arrangement. This is to be recorded in a Fuel Changeover Plan which states the procedure for entering and leaving a SECA, as well as in the ship’s log.

Logbook or record book

Ships taking on fuel oil for use on board should have a bunker delivery note, which states the sulphur content of the fuel oil supplied. The log should contain all the details for bunkering, and switching of fuels when performed, including:

- volume of fuel oils in tanks;
- date;
- time;
- position of ship;
- etc.

2.5 How it is controlled

Fuel samples may be taken for verification by Flag State. Port and coastal States can use port State control to verify that the ship is compliant, or Recognized Authority if needed. They could also use surveillance, for example air surveillance to assess vessel smokestack plumes, and other techniques to identify potential violations. This situation is rare, but has occurred on the North Sea with some regularity.

Fines upon non-compliance

Cost impact can be moderate to severe when non-compliant. It could mean the loss of license to operate, as entire sea areas need to be avoided, or retraction of the IAPP certificate. Alternatively it could mean payment of fines enacted by Flag State or Port Authorities. Hight of fines will differ per region, no information is known on the height of these fines.

3.0 NECA – NOX EMISSION CONTROL AREA

NECA	
Organization	IMO
Area	North Sea North-Americas
Effective Date	2021 (Tier III)
Keywords	Operational Restriction, Emissions, NO_x
More information	http://www.sustainable-ships.org/rules-regulations/nox
Source	Contact helpdesk
Contact	MARPOL – Contacts per flag state MEPC.6/Circ.20 – Operational contacts per flag state
Status	Active
Applicable to	All ships
Cost Impact	Severe + 50% fuel cost or €300.000+ per MW for retrofit (SCR)
Time Impact	Negligible -

3.1 Introduction

A marine diesel engine that is installed on a ship constructed on or after the following dates and operating in the below ECAs shall comply with the Tier III NO_x standard. The regulation applies globally to any installed diesel engine above 130 kW output power and sets limits [g/kWh] based on the engine speed [RPM] and vessel age. Outside these areas, vessels need to comply with Tier I or II.

- 1st January 2016 and operating in the North American ECA and the United States Caribbean Sea ECA; or
- 1st January 2021 and operating in the Baltic Sea ECA or the North Sea ECA.

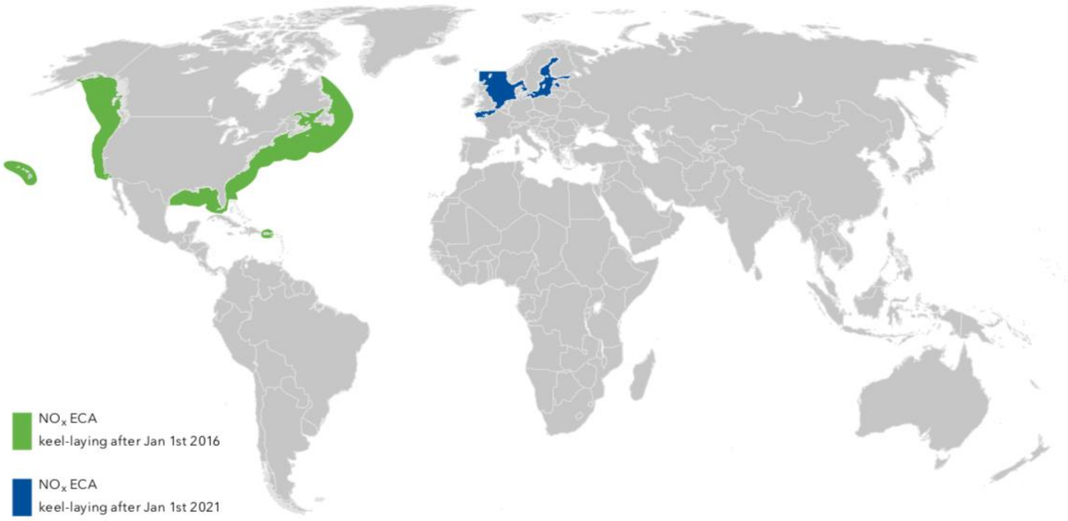


Figure 2. Pending on vessel age, ships have to conform to a maximum NO_x limit [g/kWh] when inside a NECA. These limits are called 'Tiers'.

3.1.1 About the Tiers

NO_x Tiers dictate the maximum allowable NOx emissions for a marine engine, pending ship age and location. There are three Tiers, from least stringent to most stringent these are I, II and III. The emission value for a diesel engine is to be determined in accordance with the NO_x Technical Code 2008 in the case of Tier II and Tier III limits. Most Tier I engines have been certified to the earlier, 1997, version of the NOx Technical Code which, in accordance with MEPC.1/Circ.679, may continue to be used in certain cases until 1 January 2011. Certification issued in accordance with the 1997 NOx Technical Code would still remain valid over the service life of such engines.

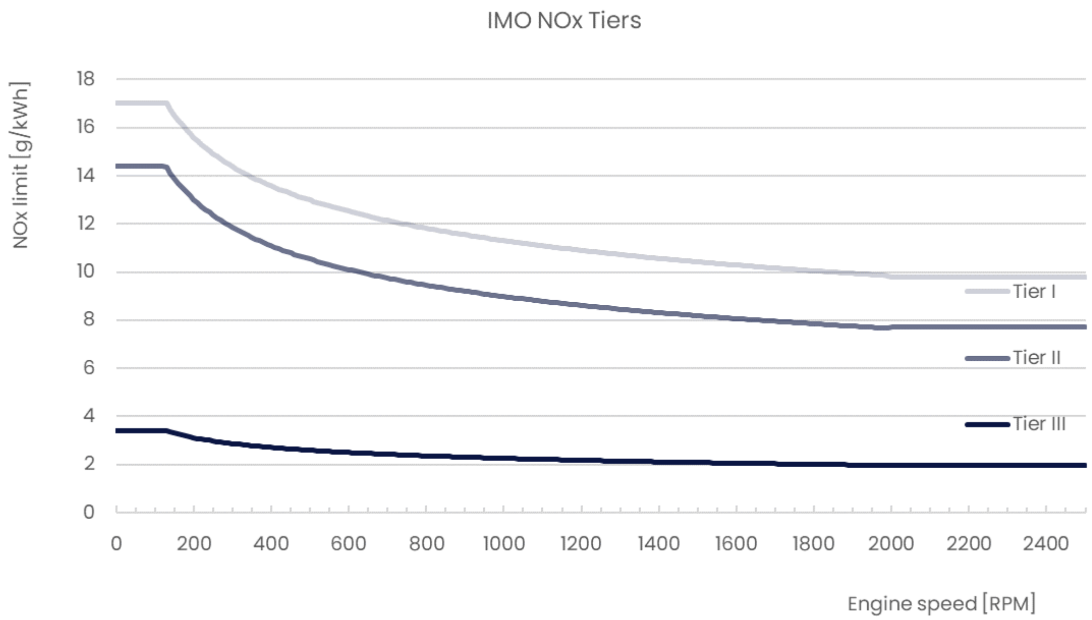


Figure 3. The exact limit of emissions in [g/kWh] is not only dependent on vessel age; each Tier's limit is determined by the engine speed in RPM. Click here to determine your limit.

Table 1. This table shows how to calculate your NO_x limit based on the year on which the ship is built, and RPM. It should be noted that Tier III only applies to vessels inside NECAs. For the North American NECAs, 2016 is used as reference date. For the North Sea and Baltic NECAs, 2021 is used as reference date.

NO_x Limit [g/kWh]				
	Ship Built	**RPM < 130**	**130 ≤ RPM <2000**	**RPM ≥ 2000**
Tier I	< 2010	17.0	$45 \cdot RPM^{-0.20}$	9.8
Tier II	> 2011	14.4	$44 \cdot RPM^{-0.23}$	7.7
Tier III	> 2016	3.4	$9 \cdot RPM^{-0.20}$	1.96

3.2 How to comply

Tier II standards are - in most cases - ensured by the engine manufacturers. Tier III standards however impose significant challenges for engine manufactures, ship operators and certifiers from a technical and operational point of view, as without specific treatment of the exhaust gases the emission limits for NOx are unlikely to be met.

Typical measures to reduce NOx emissions includes - among others - optimizing engine settings, water-injection, the use of selective catalytic reductors, or the use of electric energy storage. Below is an overview of technologies and their reduction potential to meet the Tier II and Tier III requirement by DNV. Naturally more solutions are available, such as full electric propulsion or the use of hydrogen in an electrolyser setup. These are however less practical and far from affordable in many retrofit cases and are this not shown here.

The following options may be considered to comply with regulations. More information on these can be made available by contacting the helpdesk.

Table 2. A selection of technologies that can be used for vessels when retrofitting.

Technology	NO_x Reduction Potential
Selective Catalytic Reduction	Tier III compliant
Exhaust Gas Recirculation (EGR)	Tier III compliant
LNG in lean-burn (Otto) engines	Tier III compliant
LNG in direct injection (Diesel) engines	50% reduction compared to Tier II
Direct water injection (DWI)	50% reduction compared to Tier II
Fuel-water emulsion	15-30% reduction compared to Tier II
Intake air humidification and humid air motors	30-70% reduction compared to Tier II

3.3 Cost impact

The below sections provide an indication of the costs for a few technologies.

LNG Engines

As discussed with SECA cost impact, changing to LNG as marine fuel is an option when pressed, as current-day LNG engines will be below Tier III standards. This will however have a severe cost impact and is generally not recommended for refits, but a larger number of newbuilds destined for international voyage will be using LNG (roughly 30% at the time of writing). An advantage of using LNG is that compliance to NO_x limits will be easier. A disadvantage is that IMO rules and regulations for low-flashpoint fuels will apply.

Engine modifications

It is extremely hard to determine cost impact for engine modifications which would accommodate different fuel types (such as methanol) or water intake, emulsions etc. Experience by Sustainable Ships with these kinds of technologies is limited, even though these technologies have existed for almost a hundred years in some cases. What can be stated however, is that the costs for retrofitting a marine engine would be in the order of €10-30k per cylinder. This would exclude any engineering, additional equipment, tanks, piping, maintenance, engineering hours etc.

SCR (Selective Catalytic Reductor)

Costs for an SCR system on board are in the same order of magnitude as a scrubber system (just never make the mistake of mixing an SCR with a scrubber system when speaking to experts!). As a rule of thumb, one can assume a minimum of $100 per [kW] installed. This would result in approximately $1M for a single larger marine engine. This excludes any changes that would need to be made to the ship to store the urea, or any OPEX incurred by the system itself.

3.4 How to demonstrate compliance

Engines will have to undergo engine test bed exhaust emission measurement according to MARPOL NO_x Technical Code to demonstrate that NO_x emissions are below IMO Tier required. Upon a successful test, a NO_X technical file is provided which provides detailed information on performance and emission tests, settings, components, validations etc. Additionally, an issue of the Engine International Air Pollution Prevention (EIAPP) is provided for each engine, which is valued for the entire engine life *unless major conversion occur.*

Upon inspection, the presence of valid certificates and documents should be provided. These include:

- EIAPP certificate;
- NO_x Technical file;
- Record books showing maintenance record and/or changes to engines;
- In case of changes made to engines, details of changeover or other evidence.

3.5 How it is controlled

Control is the responsibility of the Flag State, but commonly delegated to a Responsible Authority (Class). The control of diesel engine NO_x emissions is achieved through the survey and certification requirements leading to the issue of an Engine International Air Pollution Prevention (EIAPP) Certificate and the subsequent demonstration of in service compliance in accordance with the requirements of the mandatory, regulations 13.8 and 5.3.2 respectively, NOx Technical Code 2008 (resolution MEPC.177(58) as amended by resolution MEPC.251.(66)). When engines have been tested, certification is valid for engine life unless major conversion occur. Hence it is commonly not an issue during the lifetime of a ship.

4.0 FAQS

The below FAQs are a snapshot of questions available at the time of writing. Check the ECA rules and regulations section for more updates here. It should be noted that all answers have been incorporated into the previous chapters but are provided here as additional reference.

4.1 What is an ECA?

An Emission Control Area (ECA) is a sea area in which stricter controls to minimize airborne emissions from ships are established.

Initially this regulation was aimed to reduce sulphur oxides (SOX) and is extended in 2005 to include nitrogen oxides (NOX) for several areas. ECAs with restrictions on SOX only are sometimes referred to as SECAs. ECAs with restrictions on NOX are sometimes referred to as NECAs.

4.2 What are ECA requirements?

Ships sailing in emission control areas will have to use fuel oil on board with a sulphur content of no more than 0.10% (mass by mass). The interpretation of “fuel oil used on board” includes use in main and auxiliary engines and boilers.

The rules are part of the International Convention for the Prevention of Pollution form ships (MARPOL) Annex VI (Regulations for the Prevention of Air Pollution from Ships), specifically under regulation 13, which cover Nitrogen Oxides (NOx) emissions, and 14, which covers emissions of Sulphur Oxides (SOx) and particulate matter (PM) from ships.

4.3 Which ECAs are there?

The following ECAs are currently ‘active’ according to IMO:

Regulation 13 / MARPOL VI NOx control

- Baltic Sea Area
- North Sea Area
- North American Area West
- North American Area East
- Hawaii Area
- Unites States Caribbean Area

Regulation 14 / MARPOL Annex VI (SOx and PM)

- Baltic Sea Area
- North Sea Area
- North American Area West
- North American Area East
- Hawaii Area
- Unites States Caribbean Area

Click here for the exact coordinates from IMO.

4.4 Which ECAs are SOx and which are NOx constrained?

IMO Regulations under MARPOL Annex VI state that at the time of writing all ECAs are SO_x constrained (SECAs) and all ECAs are NO_x constrained (NECAs). However, the application of NO_x Tier II in the ECAs applies when the ship is constructed on:

- 1 January 2016 and operating in the North American ECA and the United States Caribbean Sea ECA; or
- 1 January 2021 and operating in the Baltic Sea ECA or the North Sea ECA.

4.5 What is the difference between ECAs and NOx tiers?

An Emission Control Area (ECA) is a general term that applies to SOx, PM and NOx emissions control. IMO NOx tiers apply to all areas and all ships constructed after a specific date. Special rules apply inside a NOx Emission Control Area (NECA).

A NECA is an area with stricter NOx emission regulations, as dictated by MARPOL Annex VI regulation 13. Within a NECA, so called Tier III NOx limits apply. Outside NECAs, the maximum applicable Tier is II. Compliance to Tier III control is also dependent on a vessel age.

In NECAs, only engines installed on a ship constructed on or after a specific date must comply with Tier III. The regulation applies globally to any installed diesel engine above 130 kW output power and sets limits [g/kWh] based on the rpm.

A marine diesel engine that is installed on a ship constructed on or after the following dates and operating in the following NECAs must comply with the below Tier III NOx standard. Outside these areas, Tier II or I applies pending vessel age.

- 1 January 2016 and operating in the North American ECA and the United States Caribbean Sea ECA; or
- 1 January 2021 and operating in the Baltic Sea ECA or the North Sea ECA.

Learn more about NOx Tiers by clicking here.

4.6 What about NOx tiers for vessels that include pre-2000 engines?

Any pre-2000 vessel has to comply with Tier I NOx limit.

2008 Annex VI Amendments (Tier II/III) adopted in October 2008 introduced not only new fuel quality requirements beginning from July 2010, Tier II and III NOx emission standards for new engines, but also Tier I NOx requirements for existing pre-2000 engines. Furthermore it applies retroactively to new engines greater than 130 kW installed on vessels constructed on or after January 1, 2000, or which undergo a major conversion after that date. 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).

4.7 How are ECA regulations controlled?

To comply with SECAs, Flag States must issue an International Air Pollution Prevention (IAPP) Certificate to the ship. This includes a section to state that the ship uses fuel oil with a sulphur content that does not exceed the applicable limit value as documented by bunker delivery notes; or uses an approved equivalent arrangement.

Ships taking on fuel oil for use on board should have a bunker delivery note, which states the sulphur content of the fuel oil supplied. Samples may be taken for verification. Port and coastal States can use port State control to verify that the ship is compliant. They could also use surveillance, for example air surveillance to assess vessel smokestack plumes, and other techniques to identify potential violations.

For NECAs, Flag States must issue an Engine International Air Pollution Prevention (EIAPP) Certificate for each engine installed on board. A NO_x Technical File for each engine is needed, which contains detailed engine testing data, measurements, validation etc.

4.8 What sanctions are there for not complying?

Sanctions are established by individual Parties to MARPOL, as flag and port States. There is no established fine or sanction set by IMO – it is down to the individual State Party.

4.9 How can ships meet the requirements?

With regards to SOx reduction, a shipowner can choose between changing fuel or installing a scrubber.

Change fuel

Ships can meet the requirements by using low sulphur fuels such as Marine Gas Oil (MGO) or Marine Diesel Oil (MDO), sometimes referred to as distillates, or even Liquified Natural Gas (LNG).

MARPOL Annex VI regulation 4.6 requires ships using separate fuel oils to carry a written procedure showing how the fuel oil change-over is to be done, allowing sufficient time for the fuel oil service system to be fully flushed of all fuel oils exceeding the applicable sulphur content prior to entry into an ECA. The volume of low sulphur fuel oils in each tank as well as the date, time, and position of the ship when any fuel-oil change-over operation is completed prior to the entry into an ECA or commenced after exit from such an area, must be recorded in such log-book as prescribed by the Administration.

Install scrubber

Alternatively one can make use of scrubbers, which remove the SOx from exhaust gasses. In this case, the equivalent arrangement must be approved by the ship's Administration (the flag State) that is a State Party to MARPOL Annex VI.

With regards to NOx reduction, multiple options are available, including:

- Selective Catalytic Reduction (SCR)
- Exhaust Gas Recirculation (EGR)
- LNG in lean-burn (Otto) engines or turbines

4.10 What are the exemptions?

Exemptions are provided for securing the safety of the ship or saving life at sea, or as a result of damage to a ship or its equipment. Also, provisions for trials for ship emission reduction and control technology research provide for a time limited exemption.

4.11 What about outside these ECAs?

Outside the emission control areas, the current limit for sulphur content of fuel oil is 0.50% [m/m]. Vessels are subject to NO_X Tier limits pending their age, either Tier I (2010 or older) or Tier II (2011 or younger).

5.0 REFERENCES

IMO	MARPOL Annex VI Regulation 13
IMO	MARPOL Annex VI Regulation 14
IMO	Emission Control Areas designated under MARPOL Annex VI Appendix VII
IMO	NOx Regulation 13
IMO	MEPC.202(62) Amendment of 1997 protocol for stricter emission control
IMO	MEPC.320(74) Guidelines for implementation of sulphur limit
REMPEC	Workshop on Ratification and Effective Implementation of MARPOL Annex VI