

MARPOL Annex VI - Prevention of Air Pollution from Ships

Chapter 3



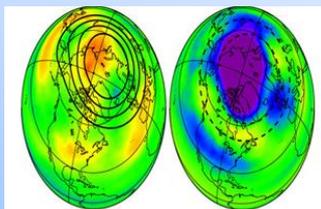
National Workshop (virtual) on Ratification and Effective Implementation of
MARPOL Annex VI for Egypt
25 November 2020

Dr Zabi Bazari
REMPEC Consultant

MARPOL Annex VI – Chapter 3 regulations

Ozone Depleting
Substances

Reg.12



Volatile Organic
Compounds

Reg.15



Nitrogen Oxides
(NO_x)

Reg.13



Shipboard
Incineration &
Reception
facilities

Regs. 16 and 17



Sulphur Oxides
(SO_x) and PM

Reg.14



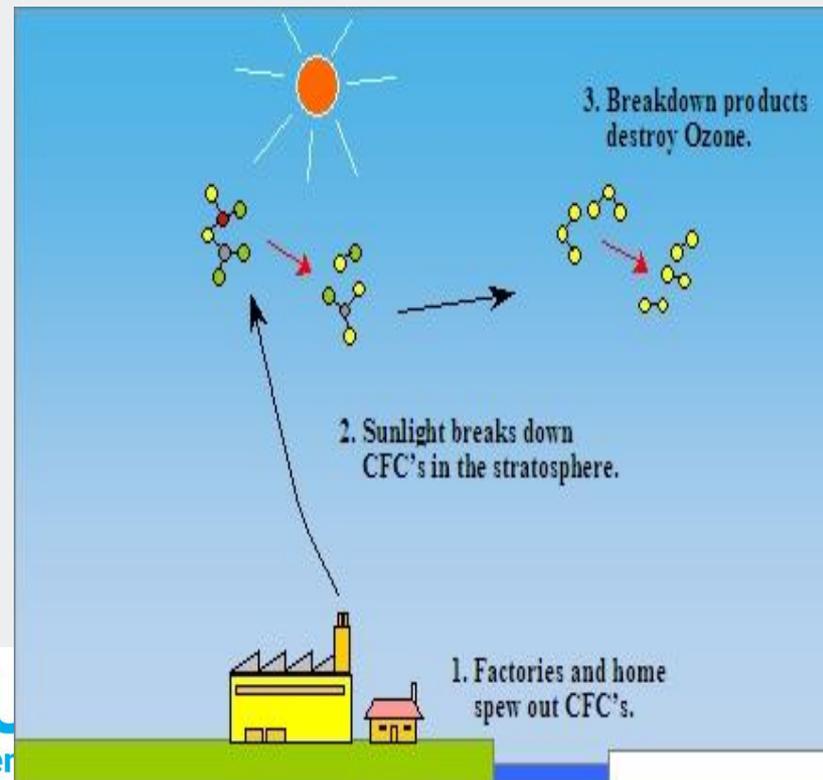
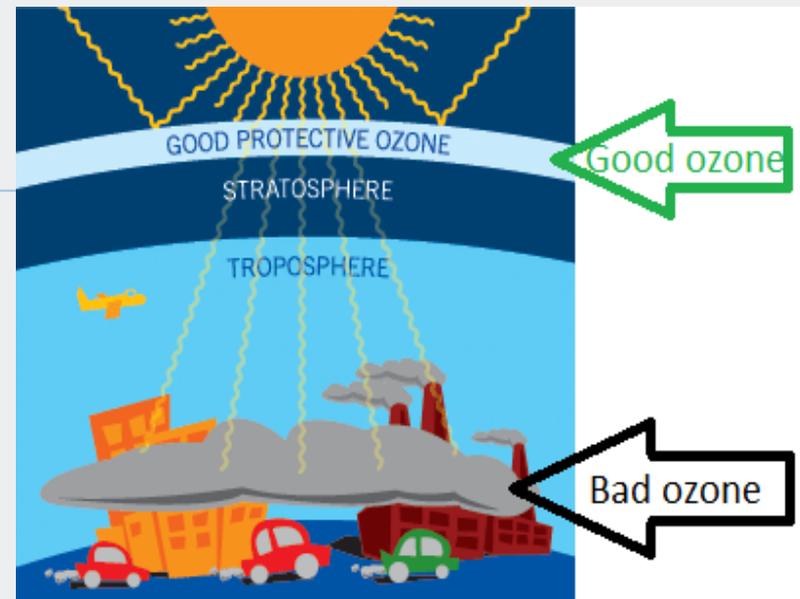
Fuel quality and
availability

Reg.18



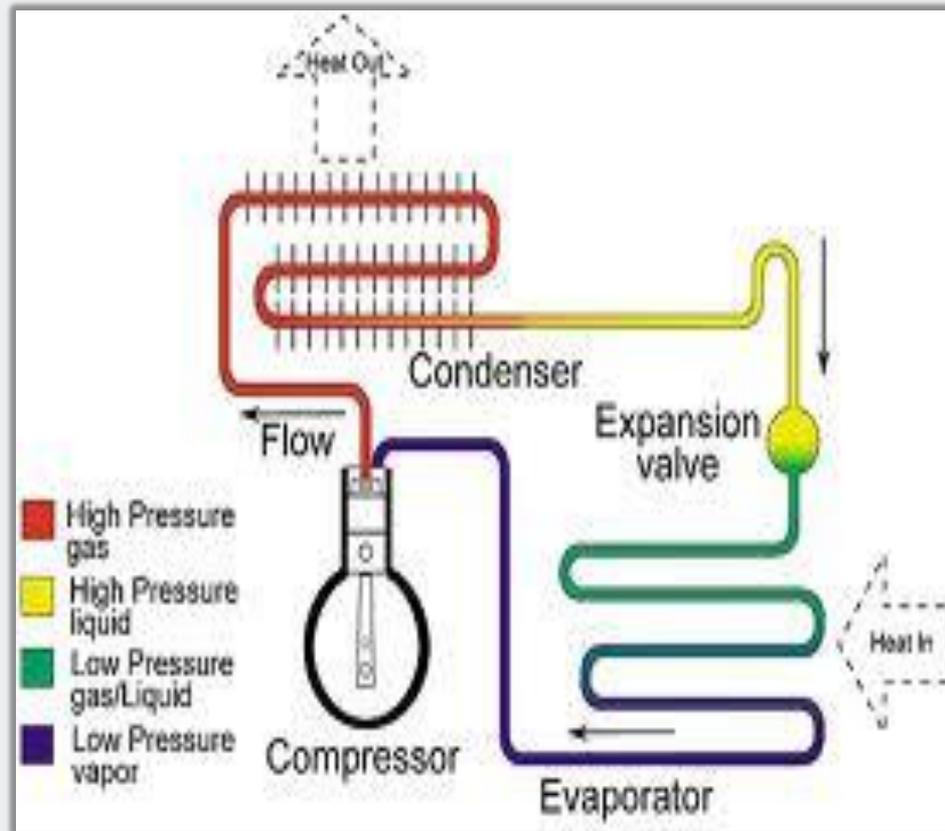
Regulation 12 – Ozone Depleting Substances (ODS)

- Ozone: O_3
- Ozone layer (~25 km from Earth): A layer in Earth Stratosphere
- Function of Ozone later: Protection of Earth from Ultra Violet sunlights.
- Ozone depletion: Refers to decline of Ozone layer causing a kind of holes (the ozone hole).
- ODS: Primary cause of ozone depletion is the presence of chlorine-containing gases (CFCs)
- Process: ODSs from industry → Dissociation under sunlight → Chlorine formation → Destruction of O_3 .

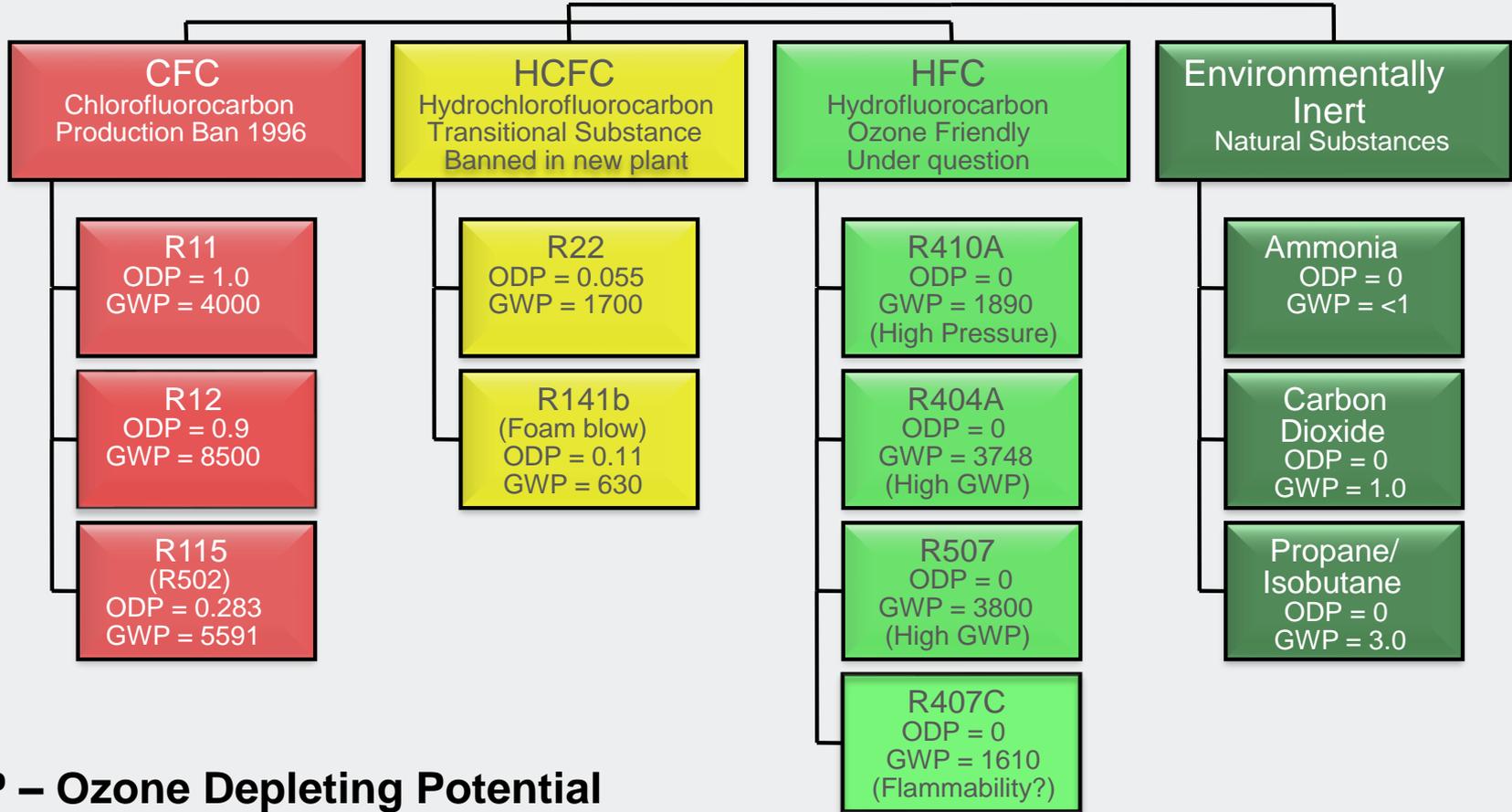


Where on-board ships ODS are used?

- In the AC (Air Conditioning) and refrigeration systems (fridge, freezers, etc.).
- Fire extinguishing systems



Refrigerants - Family Tree, ODP, GWP



ODP – Ozone Depleting Potential

GWP – Global Warming Potential

Montreal Protocol – Prevention of Ozone Depletion

Montreal Protocol:

International treaty designed to protect the ozone layer by **phasing out the production and use of ODS**.

- Entered into force on 1 January 1989



IMO has used the Montreal Protocol as the base and developed regulation 12 with main aim of: Phasing out the harmful ODS used by ships.

Regulation 12 – Ozone depleting substances (ODS)

- Does not apply to **permanently sealed units** (Reg.12.1) with no refrigerant charging connections ...
- Any **deliberate emissions** prohibited (Reg.12.2)
- Other than Hydrochlorofluorocarbon (HCFC) all other ODS banned in new ships from **19 May 2005** (Reg.12.3.1)
- HCFC banned in new ships from **1 January 2020** (Reg.12.3.2)
- Delivery to **reception facilities** following removal (Reg.12.4)

Where the ODS containing equipment located on-board the ship?

- Supplement to IAPP Certificate - Maintain a list of equipment containing ODS (Reg.12.5)

2 Control of emissions from ships

2.1 Ozone depleting substances (regulation 12)

2.1.1 The following fire-extinguishing systems, other systems and equipment containing ozone depleting substances, other than hydro-chlorofluorocarbons, installed before 19 May 2005 may continue in service:

System or equipment	Location on board	Substance

2.1.2 The following systems containing hydro-chlorofluorocarbons (HCFCs) installed before 1 January 2020 may continue in service:

System or equipment	Location on board	Substance

How to find what has happened to ODS material and equipment?

Ships are required to complete an **ODS Record Book** (Reg. 12.6) for rechargeable systems

Entries in the ODS Record Book (Reg.12.7) include mass (kg) of substance used for:

- Recharge, full or partial, of equipment containing ODS;
- Repair or maintenance of equipment containing ODS;
- Discharge of ODS to the atmosphere;
- Discharge of ODS to land-based reception facilities;
- Supply of ODS to the ship.

Description of Equipment	Date	Quantity kg	ODS Name	Discharge to atmosphere	Land base discharge	New Supply to ship	Remarks Ch. Eng. Signature
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	
				deliberate non-deliberate	Yes / No N/A	Yes / No N/A	

MARPOL Annex VI – Regulation 13

Nitrogen Oxides (NO_x)

What is NO_x

- NO_x: Refers to oxides of nitrogen → **NO₂ and NO**
- Formed in the process of fuel combustion at **high temperatures**.
- Marine **Diesel engines** emit most NO_x (high efficiency and low speed)
- NO_x from other sources (e.g. **boilers**) are relatively small.
- NO_x is a pollutant and causes damage:
 - Lung irritation
 - Ground level Ozone and smog (smoky fog)
 - Acid rain

Regulation 13 NO_x - Application

Applies to



Marine diesel engines ⇒ with a power output more than **130 kW** ⇒ installed on a ship constructed on or after 1 January 2000

Applies to



Marine diesel engines ⇒ with a power output more than **130 kW** ⇒ which undergo a **major conversion** on or after 1 January 2000

Applies to



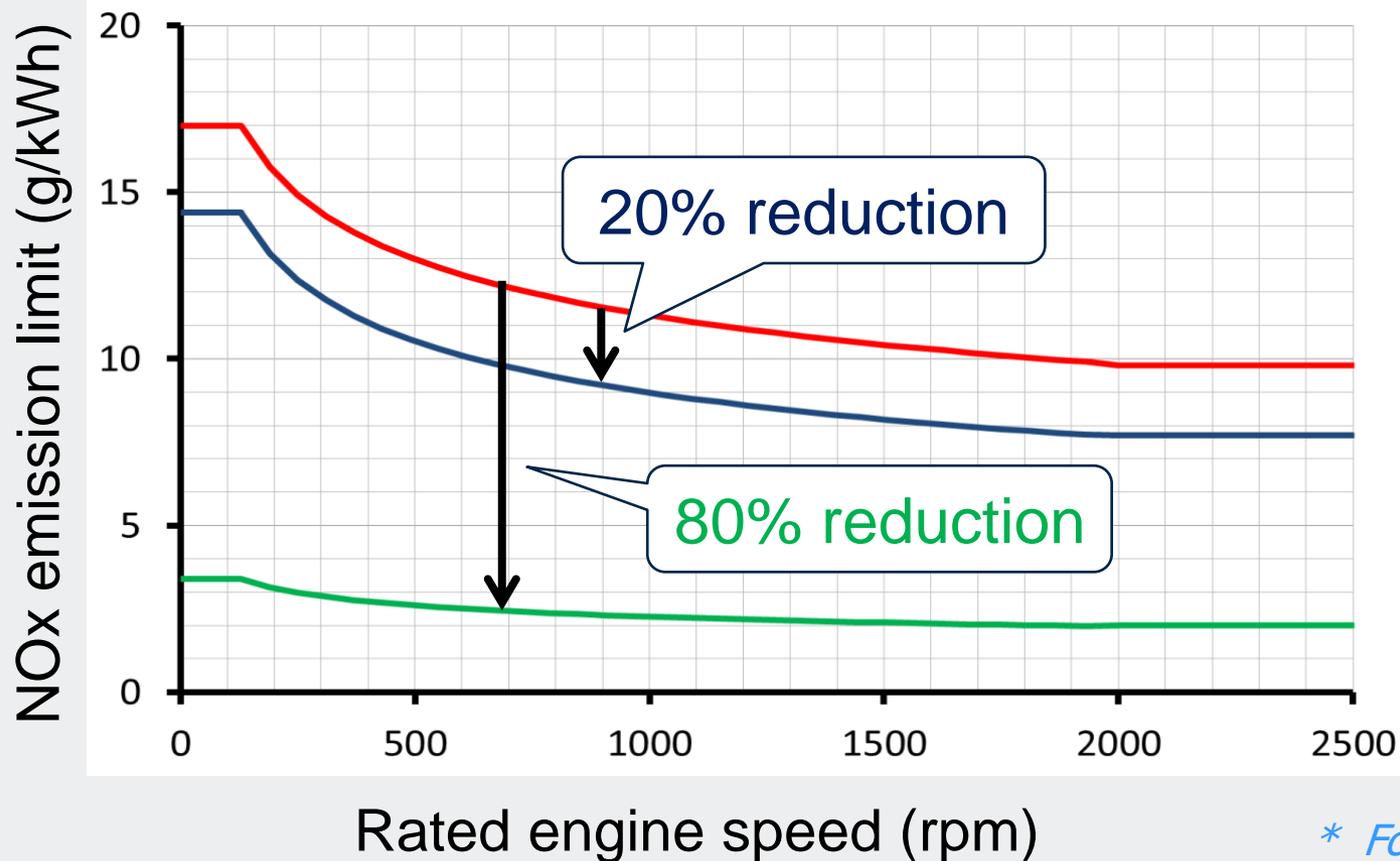
Marine diesel engines ⇒ with an Approved Method ⇒ Installed on a ship constructed on or **1 Jan 1990 to 31 Dec 1999**

Not applicable to



- Emergency marine diesel engines
- Marine diesel engines installed on lifeboats
- Any device or equipment intended to be used solely in case of emergency
- Engines on ships only engaged in domestic voyages can be made subject to alternative NO_x control measure or exempted if pre-19 May 2005

Regulation 13 - NOx emission limits



Tier I

- Constructed on or after 1 Jan. 2000

Tier II

- Constructed on or after 1 Jan. 2011

Tier III*

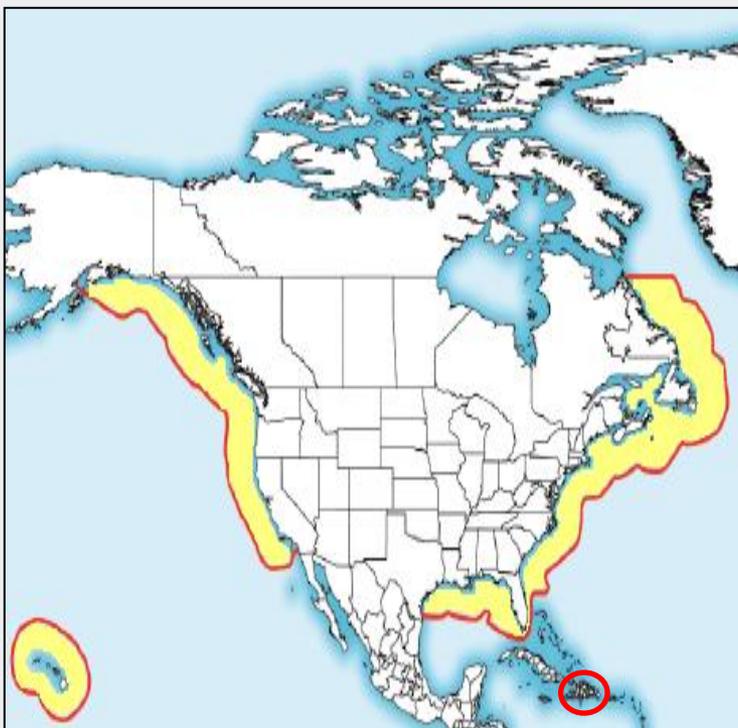
- Constructed on or after 1 Jan. 2016
- Applied in ECAs
- Tier II applied outside of ECAs

** For a ship operating within North American ECA and US Caribbean Sea Area ECA*

Tier III

Emission Control Areas (ECAs) for NO_x emission control

North America ECA + US Caribbean ECA for **ships constructed on or after 1 January 2016**



North Sea and Baltic Sea ECA NO_x :
Applicable to **ships constructed on or after 1 January 2021.**



Pre-2000 engines

Regulation 13 – Approved methods

Ships constructed - 1 Jan 1990 to 31 Dec 1999:

- Required to fit an “**approved method**” to enable the engine to meet Tier I NO_x emission limits
- IMO to be notified of approved method
- The approved method to be installed at first renewal survey 12 months after IMO notified the “method” is approved



Regulation 13 - Approved Method examples

MEPC.1/Circ.845 (List of Notifications from Administrations, as of July 2014)

Date of notification	Administration	Engine type	Manufacture	Type of approved method	MCR per cylinder (kW/cyl)	Rated speed (rpm)	IMO Circular No.
5 October 2010	Denmark	S70MC	MAN B&W	Fuel nozzle	2,530 – 2,810	81 – 91	MEPC.1/Circ.738 MEPC.1/Circ.738/Add.1 MEPC.1/Circ.738/Add.2 MEPC.1/Circ.738/Add.3/Rev.1
4 February 2011	Germany	RTA52 RTA52U RTA58T RTA62 RTA62U RTA72 RTA72U RTA84C RTA84CU RTA84M RTA84T-B RTA96C	Wärtsilä Switzerland Ltd.	NO _x optimized injection timing	---	---	MEPC.1/Circ.743
11 August 2011	Denmark	S70MC	MAN B&W	Fuel nozzle	2,250 – 2,810	81 – 91	MEPC.1/Circ.764 MEPC.1/Circ.764/Add.1
11 August 2011	Denmark	S50MC	MAN B&W	Fuel nozzle	1,160 – 1,430	114 – 127	MEPC.1/Circ.765
5 October 2011	Denmark	S60MC	MAN B&W	Fuel nozzle	1,650 – 2,040	94 – 105	MEPC.1/Circ.770
4 June 2014	Denmark	L50MC	MAN B&W	Fuel nozzle	1,075 – 1,330	133 – 148	MEPC.1/Circ.837

Any up-to-date information will be available on: <http://gisis.imo.org/Public/>



Regulation 13 (NO_x) – Engine certification

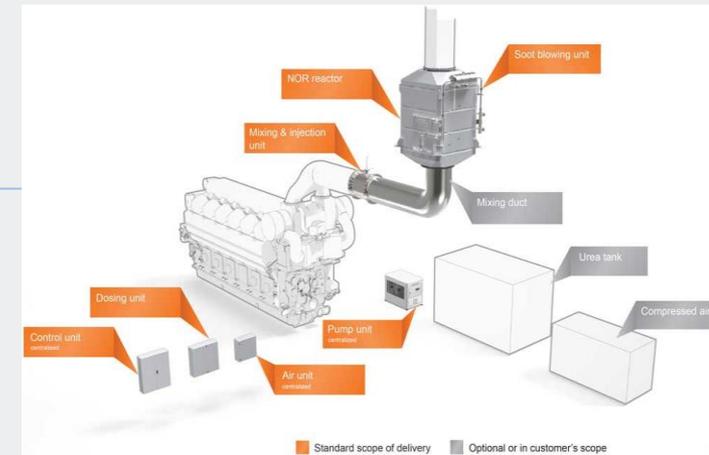
- Test bed exhaust emission measurement according to NO_x Technical Code (NTC)
 - To demonstrate that NO_x is below the IMO Tier.
- **NO_x Technical File**
 - Information on performance and emissions tests + components, settings, operating values & adjustments to be observed
- Issue of **Engine International Air Pollution Prevention (EIAPP)** Certificate or statement of compliance for an engine:
 - Issued for each engine
 - Valid for the engines life (unless major conversion)

There are options for ship-board measurement, verification and certification but not practiced due to complexity of measurements.

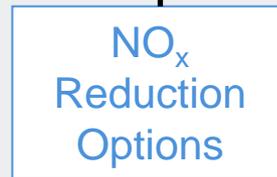
Methods for engine's NO_x reduction

Certification and compliance aspects

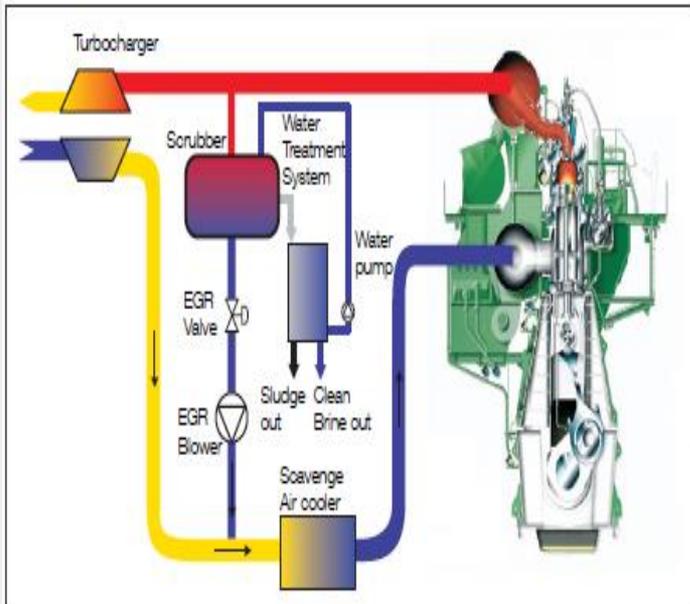
- Lean burn
- low temperature combustion



- Use of a reduction agents
- Uses a catalyst
- Converts NO_x back to N₂



Low combustion temperature due to gas recirculation (mainly CO₂)



Source: MAN publication: Tier III compliance – Slow speed engines

How to demonstrate compliance for NO_x?

- Presence of valid certificates and documents:
 - EIAPP Certificate
 - NO_x Technical File
 - Logbooks showing maintenance records and changes to engines
 - In case of NO_x changeover for ECA, details of changeover;
 - Detailed examination of each engine to show validity and correct settings/practices
 -

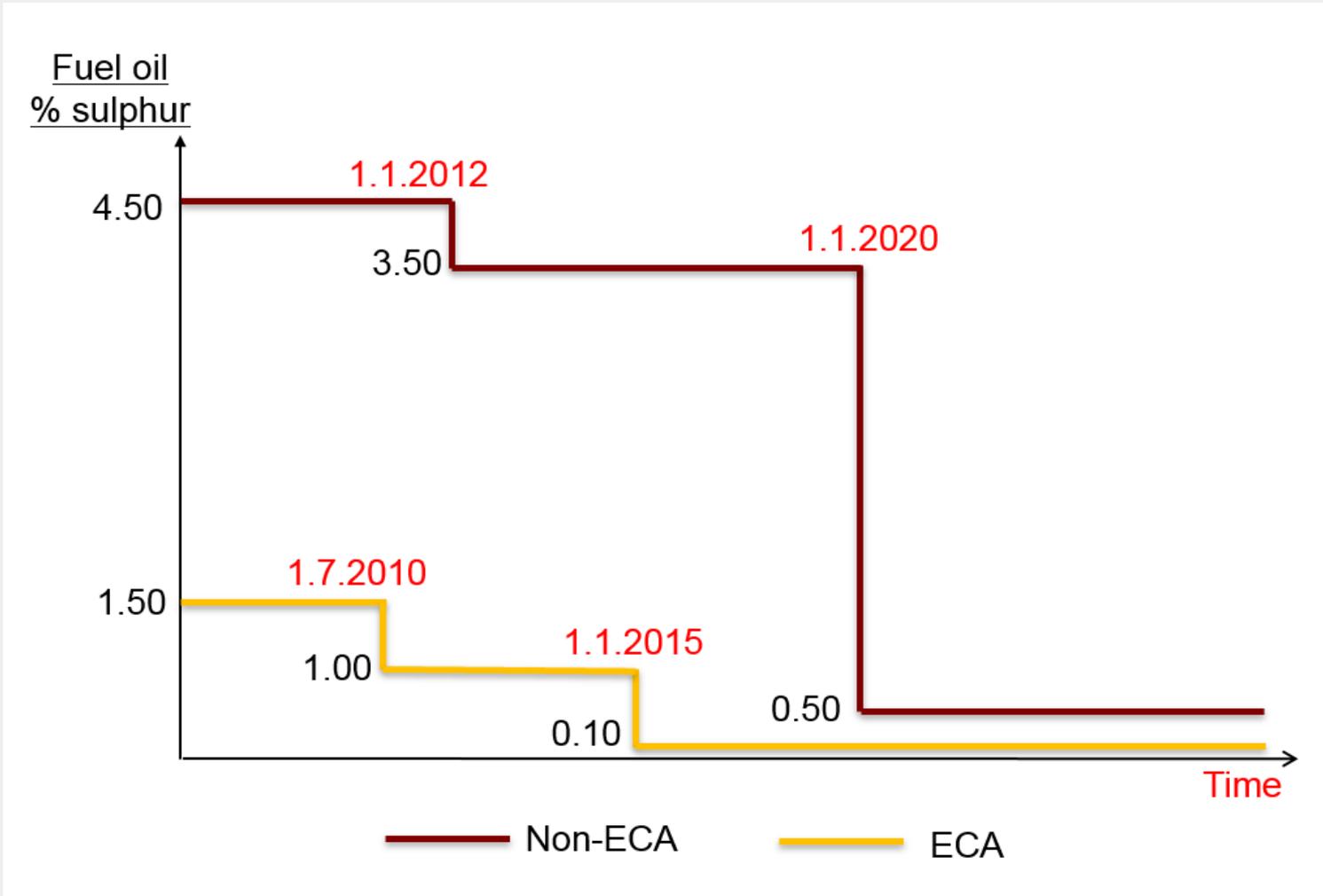
MARPOL Annex VI – Regulation 14

Sulphur Oxides (SO_x) and Particulate Matter

How SO_x is produced and what is its impact?

- SO_x is normally SO₂ and to some extent SO₃.
- SO_x is produced from combustion of sulphur contained in the fuel
 - $S + O_2 \rightarrow SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$
- SO_x causes:
 - Acid rain
 - Sea and soil acidification and
 - Human health issue.

Regulation 14 – Fuel sulphur limits



Emission Control Areas (ECAs) for SO_x emission control

North Sea and Baltic Sea ECAs



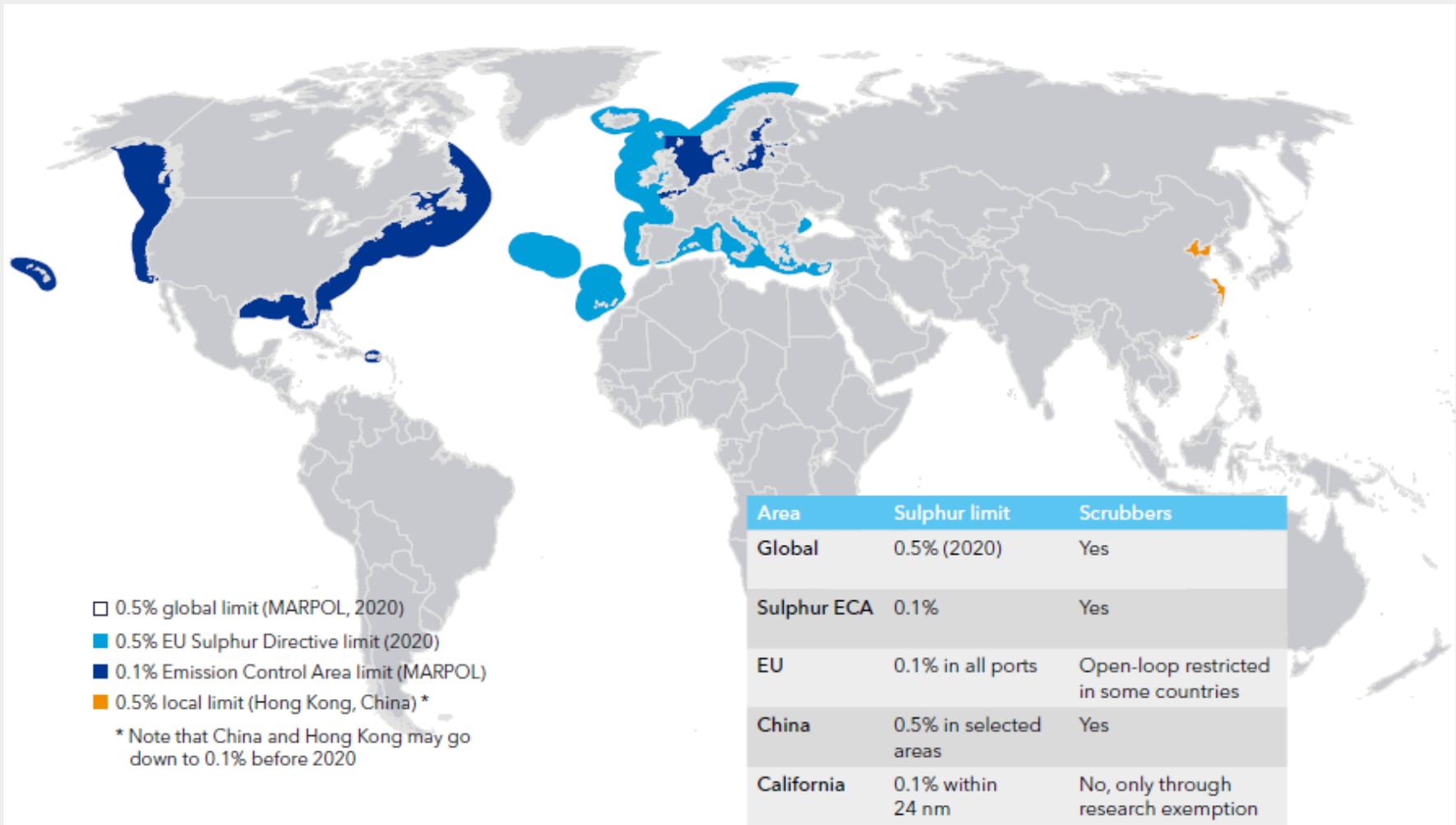
North American ECA (Effected from 01/08/2012)



U.S. Caribbean ECA (Effected from 01/01/2014)



IMO ECA-SOx and non-IMO SOx control regions



Extended China Domestic ECA (DECA) is now in place.

SO_x compliance options

- **Multi-fuel options:** 2 or more separate fuels on-board, i.e. LS and HS fuel oils.
- **LNG as marine fuel or other alternative fuels:** Specific regulations applies.
- **SO_x scrubber systems:** Specific regulations applies (equivalent method: 2015 Guidelines for exhaust gas cleaning, resolution MEPC.259(68))

Demonstrating compliance to ECA for two-fuel option (Reg. 14.6)

- **Fuel Changeover Plan:** For ships with two fuels when and entering or leaving an ECA-SOx
- **Logbook/Record Book:** Record all the details of switching fuels including:
 - Volume of low sulphur fuel oils in each tank
 - Date,
 - Time
 - Position of the ship
 - Etc.

Compliance to 2020 Sulphur limit – Carriage Ban

- Carriage ban of carrying any fuel with sulphur > 0.5% (Regulation 14.1.3)
 - Unless scrubber is used.
- Ships can still carry high sulphur fuel as cargo but not as fuel.

Guidance documents or industry best practice in support of 2020 Sulphur Cap

2020 sulphur cap – Guideline for consistent implementation (Resolution MEPC 320(74)), adopted May 2019

Guidelines intended for use by Administrations, port States, shipowners, shipbuilders and fuel oil suppliers. Main content:

1. **Definitions** (DM, RM, ULSFO, VLSFO, HSHFO)
2. **Ship implementation planning** for 2020 (cf: MEPC.1/Circ.878)
3. **Impact on fuel and machinery systems**: distillate fuels (including distillate fuel with FAME) / Residual fuels / Key technical considerations for shipowners and operators / ISO Standard for residual fuels / Cylinder lubrication
4. **Verification issues and control mechanism and actions**: Survey and certification by Administrations / Control measures by port States / Control on fuel oil suppliers / Information sharing related to non-compliances under MARPOL Annex VI
5. **Fuel oil non-availability**: Guidance and information sharing on fuel oil non-availability / Standard format for reporting fuel oil non-availability (FONAR) – Appendix 1
6. **Possible safety implications** relating to fuel oils meeting the 0.50% m/m sulphur limit – Appendix 2

Guidance on the development of a ship implementation plan

Guidance on the development of a ship implementation plan for consistent implementation of the 0.50% sulphur limit under MARPOL Annex VI (MEPC.1/Circ.878) – issued November 2018

This guidance includes an indicative plan that identifies the following key elements:

- .1 risk assessment and mitigation plan (impact of new fuels);
- .2 fuel oil system modifications and tank cleaning (if needed);
- .3 fuel oil capacity and segregation capability;
- .4 procurement of compliant fuel;
- .5 fuel oil changeover plan (conventional residual fuel oils to 0.50% sulphur compliant fuel oil); and
- .6 documentation and reporting.

Additional guidance that could be taken into account is provided on impact on machinery systems and on tank cleaning.

Appendix 1, Fuel Oil Non-Availability Report (FONAR)

“3.1 A fuel oil non-availability report is not an exemption. According to regulation 18.2 of MARPOL Annex VI, it is the responsibility of the Party of the destination port, through its competent authority, to scrutinize the information provided and take action, as appropriate.”

The FONAR includes the following sections:

1. Particulars of the ship
2. Description of ship's voyage plan
3. Evidence of attempts to purchase compliant fuel oil
4. In case of fuel oil supply disruption only
5. Operation constraints, if applicable

“If non-compliant fuel has been bunkered due to concerns that the quality of the compliant fuel available would cause operational or safety problems on board the ship, the concerns should be thoroughly documented.”

6. Plans to obtain compliant fuel oil
7. Previous Fuel Oil Non-Availability Reports
8. Master/Company information

➤ Master's signature and date



Consequential regulatory amendments approved by MEPC 74 (May 2019)

- Approved draft amendments, following adoption at MEPC 75 (March/April 2020), would be expected to enter into force on 1 September 2021
- Draft definitions prepared as amendments to regulation 2 of MARPOL Annex VI:
 - 52** *Sulphur content of fuel oil* means the concentration of sulphur in a fuel oil, measured in % m/m as tested in accordance with a standard acceptable to the Organization. (Refers to ISO 8754 in footnote)
 - 53** *Low-flashpoint fuel* means gaseous or liquid fuel oil having a flashpoint lower than otherwise permitted under paragraph 2.1.1 of SOLAS regulation II-2/4.
 - 54** *MARPOL delivered sample* means the sample of fuel oil delivered in accordance with regulation 18.8.1 of MARPOL Annex VI.
 - 55** *In-use sample* means the sample of fuel oil in use on a ship.
 - 56** *On board sample* means the sample of fuel oil intended to be used or carried for use on board that ship.
- **New draft provisions added to regulation 14 of MARPOL Annex VI include:**
 - **In use and on board fuel oil sampling and testing, including requirement to have sampling points for taking representative samples and testing regulations for fuel oil used on board**

2020 sulphur cap – Joint Industry Guidelines and Training Course

- The Joint Industry Guidance includes the following sections:
 - Section 1: Guidance on fuel characteristics and properties
 - Section 2: Guidance on the supply of max. 0.50%-sulphur fuels
 - Section 3: Guidance on the storage, handling and safe use of 30max. 0.50%-sulphur fuels
- Developed a training course on the subject: marine fuel”:
http://videoteltraining.com/courses/1374/#1_1



MARPOL Annex VI – Regulation 15

Volatile Organic Compounds (VOC)

What is VOC and its impact?

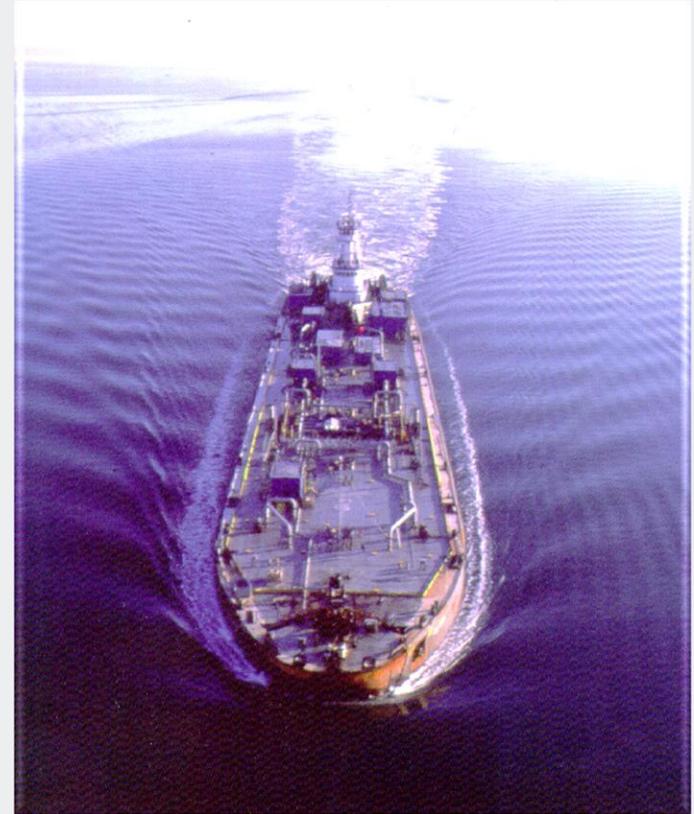
Volatile Organic Compounds (VOCs) are:

- Lighter parts of crude oil or their products that evaporates during voyage and ship loading process
- Health issue: Carcinogenic, etc.
- Not toxic but long term health impact.

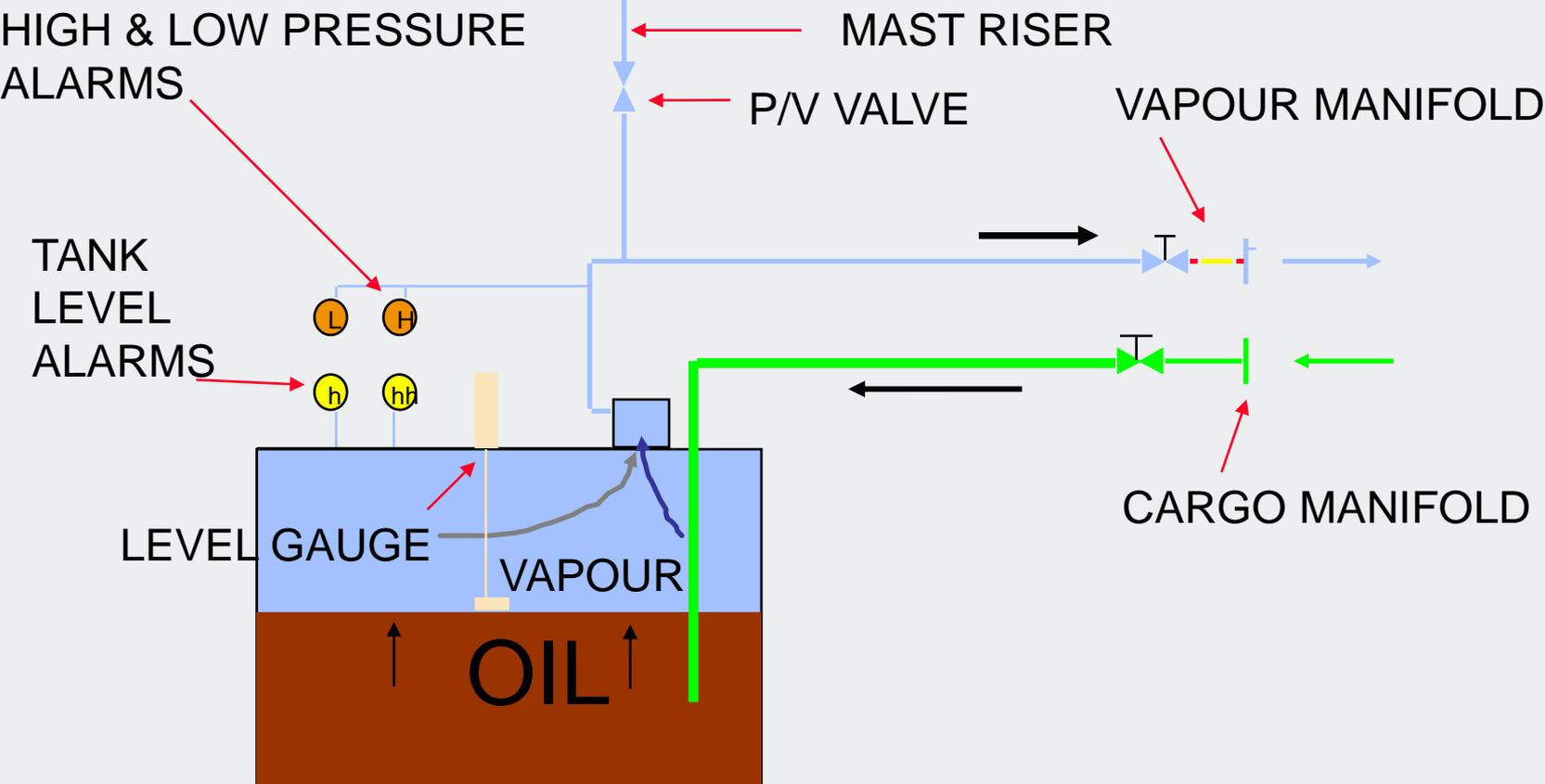
- VOCs in shipping:
 - Mainly from **oil tankers**
 - Normally polluting the **port of loading**
 - Also due to oil tank purging / cleaning processes

Regulation 15 - VOC

- Regulation enables **ports and terminals** to implement VOC controls
- **VOC control from tankers** during loading/unloading of oil cargoes
- **Vapour Emissions Control System (VECS)** to be compliant with MSC/Circ. 585 guidelines
- Crude oil tankers to have an approved **VOC Management Plan** (does not apply to gas carriers - Reg. 15.7)



How to reduce the VOC emissions: Use a Vapour Emission Control System (VECS)



Regulation 15 - VOC

- Notification:
 - Relevant port(s) and terminal(s): Notify IMO 6 months before effective date (Reg.15.2)
 - IMO shall circulate list of ports and terminals (Reg.15.4)



- Ports/terminals with approved VECS can accept tankers without VECS for up to 3 years after effective date (Reg.15.5)
- Gas carriers:
 - Regulation applies for retention of non-methane VOCs (Reg.15.7)
 - Not required to have a VOC Management Plan.

MARPOL Annex VI – Regulation 16

Shipboard Incineration

Regulation 16 - Shipboard incineration

- **Prohibits incineration of (Reg.16.2):**
 - 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.

- **Permits incineration of:**
 - PVC – plastics (where type approved to do so) (Reg.16.3)
 - Sewage sludge and sludge oil (generated during normal operation of engines and boilers). This is not permitted in ports, harbours and estuaries (Reg.16.4)

Regulation 16 - Shipboard incineration – Design and Operation

- **Certificate** needed for all incinerators installed from 1 January 2000.
- Incinerator shall be provided with a **manufacturer's operating manual** which is to be retained
- Personnel to be trained in use (Reg. 16.7 – 16.8).
- For compliance: combustion chamber temperature should reach 600 °C within 5 minutes of start-up.
- All incinerators should have a combustion flue gas **outlet temperature monitoring system**.

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Regulation 16 - Shipboard incineration

- Incinerators design to comply with MEPC.244(66) on “**2014 Standard Specification for Shipboard Incinerators**” (Reg. 16.6.1).
- These Guidelines include topics:
 - Scope
 - Definitions
 - Materials and manufacture
 - Operating requirements
 - Operating controls
 - Other requirements
 - Tests
 - **Certification**



Source: MIURA industries

MARPOL Annex VI – Regulation 17

Reception Facilities

Regulation 17 – Reception Facilities

- Parties are obliged to provide facilities without causing delay for:
 - Reception of ODS in ship repair yards (Reg.17.1.1); and
 - Reception of Exhaust Gas Cleaning System residues (Reg.17.1.2)
- Reception of ODS in ship breaking facilities (Reg.17.1.3)
- If unable to provide reception facilities, Party shall inform IMO (Reg.17.3 & 17.4).
- Each Party shall notify the Organization of all cases where the facilities provided under this regulation are unavailable or alleged to be inadequate.

MARPOL Annex VI – Regulation 18

Fuel oil availability and quality

Regulation 18 – Fuel oil availability

- Parties to promote availability of compliant fuel oils (Reg.18.1)
- Ships found not to be in compliance (Reg.18.2.1)
 - Record of actions taken to achieve compliance
 - Need to demonstrate “best efforts” to obtain compliant fuel
- Ship should not be required to deviate or delay unduly the voyage in order to achieve compliance (Reg.18.2.2).
- Party required to take into account all relevant circumstances to determine action (Reg.18.2.3).
- Ship required to notify Administration and port of destination when unable to purchase compliant fuel (Reg.18.2.4).
- Party to notify the Organization when ship presents evidence of non-availability (Reg.18.2.5)



Global Integrated Shipping Information System

FONAR (Fuel Oil Non-Availability Reporting)

- If not in compliance, operators must:
 - Submit a FONAR
 - Notify Flag State
 - Notify Post State
- The FONAR means 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.

APPENDIX 1

FUEL OIL NON-AVAILABILITY REPORT (FONAR)

Note:

1 This report is to be sent to the flag Administration and to the competent authorities in the relevant port(s) of destination in accordance with regulation 18.2.4 of MARPOL Annex VI. The report shall be sent as soon as it is determined that the ship/operator will be unable to procure compliant fuel oil and preferably before the ship leaves the port/terminal where compliant fuel cannot be obtained. A copy of the FONAR should be kept on board for inspection for at least 36 months.

2 This report should be used to provide evidence if a ship is unable to obtain fuel oil compliant with the provisions stipulated in regulations 14.1 or 14.4 of MARPOL Annex VI.

3 Before filing a FONAR, the following should be observed by the ship/operator:

.1 A fuel oil non-availability report is not an exemption. According to regulation 18.2 of MARPOL Annex VI, it is the responsibility of the Party of the destination port, through its competent authority, to scrutinize the information provided and take action, as appropriate.

3.2 In the case of insufficiently supported and/or repeated claims of non-availability, the Party may require additional documentation and substantiation of fuel oil non-availability claims. The ship/operator may also be subject to more extensive inspections or examinations while in port.

3.3 Ships/operators are expected to take into account logistical conditions and/or terminal/port policies when planning bunkering, including but not limited to having to change berth or anchor within a port or terminal in order to obtain compliant fuel.

Regulation 18 – Fuel oil quality

- Required properties of fuel oil identified (Reg.18.3).
- When bunkering fuel, receive a Bunker Delivery Note (BDN) containing information in Appendix V (Reg. 18.5).
- BDN required to be retained for 3 three years (Reg. 18.6).
- BDN accompanied by representative sample, ... retained under the ship's control for 12 months (Reg.18.8.1).
- Verification of bunker sample to be done in accordance with Appendix VI (Reg.18.8.2).
- Inspection and verification by PSC (Reg.18.7.1 & Reg.18.7.2).



Regulation 18 – Bunker Delivery Note (BDN)

BDN to include the following information:

- Name and IMO number of receiving ship
- Port and Date of commencement of delivery
- Name, address and telephone number of fuel supplier
- Product name and Quantity
- Density
- Sulphur content (actual)
- Declaration signed by supplier that the fuel oil conforms with Annex VI Regulations.

Regulation 18 - Local suppliers of fuel oil

Parties are required to:

- Maintain a register of local suppliers of fuel oil (Reg.18.9.1)
- Require local suppliers of fuel oil to provide a certified BDN and sample (Reg.18.9.2), and retain a copy of the BDN for 3 years (Reg.18.9.3)
- Take action against local suppliers of fuel oil that does not comply with that stated on BDN (Reg.18.9.4)
- Inform the Administration of a ship when the ship is found to be non-compliant (Reg.18.9.5)
- Inform IMO of all cases of non-compliant fuel oil being supplied (Reg.18.9.6)



Global Integrated Shipping Information System

MARPOL Annex VI – Appendix III

Designation of ECAs

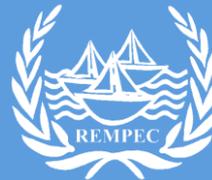
Designation of ECAs

- Appendix III to MARPOL Annex VI defines “**criteria and procedures for designation of ECAs** (relating to Regs. 13.6 (NO_x) and 14.3 (SO_x)).
- A proposal to IMO for designation of an ECA by relevant Parties.
- Main criteria to be included:
 - Clear definition of proposed area
 - Type of emission(s) to be controlled (NO_x, SO_x, PM)
 - Description of human populations and environmental areas at risk
 - An environmental impact assessment of ships in the area and benefits
 - ...
- IMO, after due consideration, will amend MARPOL Annex VI using normal procedures (MEPC debates, agreement, adoption, bringing into force, etc.).

Self assessment: True or False?

1. CFC and HCFC and HFC are all Ozone-Depleting Substance?
2. CFC, HCFC and HFC are all strong GHG gases?
3. All the ODS containing equipment must be listed in the Supplement to IAPP Certificate?
4. All ship-board diesel engines must be listed in the Supplement to IAPP Certificate?
5. All ship-board diesel engines must have an EIAPP certificate?
6. BDNs should be retained on board for at least 3 years?
7. Fuel samples need to be retained on board for at least 3 years?
8. There is no requirements for Port Reception Facilities under MARPOL Annex VI?
9. Ships are prohibited to carry non-compliant fuels unless as cargo.

REMPEC, an IMO / UNEP Centre assisting the Mediterranean coastal States in ratifying, transposing, implementing and enforcing international maritime conventions related to the protection of the marine environment



Thank you

Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC)
Maritime House, Lascaris Wharf, Valletta, VLT 1921, Malta
T: +356 21 337 296/7/8 | F:+356 21 339 951
rempec@rempec.org

www.rempec.org