



# MARPOL Annex VI – Nitrogen Oxides

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Technical Assistance

Turkey / 13<sup>th</sup> to 15<sup>th</sup> January 2020



# Outline



- Introduction: why is (NO<sub>x</sub>) air pollution a problem?
- MARPOL Annex VI – NO<sub>x</sub>
- NO<sub>x</sub> Technical Code

# Increasing awareness on air quality




**BBC NEWS**

Science & Environment

### Polluted air causes 5.5 million deaths a year new research says

By Jonathan Amos  
BBC Science Correspondent, Singapore (2)

12 February 2016 Science & Environment



**M Pollutions**

PLANÈTE POLLUTIONS

### Nouveau pic de pollution à Paris

La semaine du 01-01-2016 à 08:00 - 08:00 à par le 20-01-2016 à 18:00



Le stationnement résidentiel est gratuit, mercredi 20 janvier à Paris, en raison d'un nouvel épisode de pollution atmosphérique. Auparavant, l'association de

**Süddeutsche Zeitung**  
SZ.de Zeitung Magazin

### Die Luft bleibt dreckig - mindestens bis 2030

5. Februar 2015, 12:48 Uhr München/Österreich



Der Straßenverkehr ist hauptverantwortlich für die schlechte Luft in den Städten. Die Industrie stellt in moderner Euro-6-Diesels die Lösung. Doch die wird nicht immer so sauber wie versprochen.

**Wojna ze smogiem**

Dziennik Wroclawski 01.02.2016 01:00



Najgorszej jakości węgiel i przestarzałe piece idą w odstawkę. Po Krakowie uchwał antysmogowych chcą władze Wrocławia i Legnicy, a marszałek Śląska przepisami antysmogowymi zamierza obciążyć ponad 100 gmin.

**EL PAÍS**

ESPAÑA · Madrid

### La capital vulnera por sexto año seguido los límites de contaminación

- El informe anual de Ecologistas en Acción concluye que en 2015 los niveles de contaminación han sufrido un incremento notable
- Las alertas por contaminación se vuelven cotidianas
- Intermite pasar muy poco tiempo al aire libre

ESTHER SÁNCHEZ Madrid 13.01.2016 - 21:27 CDT



### The world's largest cruise ship and its supersized pollution problem

An Harmony of the Seas sets sail from Southampton docks on Sunday she will leave behind a trail of pollution - a toxic problem that is growing as the cruise industry and its ships get even bigger



**LE SOIR**

### La qualité de l'air belge est l'une des plus mauvaise d'Europe

Belgique est, juste derrière la Monténégro, le pays européen où la qualité de l'air est la moins bonne, indique un NPM d'associations anti-smog.



**De Morgen**

### Fijnstofconcentraties blijven hoog door gebrek aan wind

25-01-16 14:28u - Bron: De Persgroep



Ook maandag en de volgende dagen blijven de meteorologische omstandigheden van die aard dat de fijnstofconcentraties hoog

# Why air pollution is a problem



Europe's air quality is slowly improving, but fine particulate matter and ground-level ozone in particular continue to cause serious impacts on health.

Estimates point to well above 400.000 premature deaths in EU-28 each year due to particulate matter; and more than 15.000 due to ground-level ozone.

1 out of 10 EU citizens are exposed to particulate matter concentrations above the EU limit value; with 9 out of 10 exposed above WHO guidelines.

Assessed against EU Limit Value

8-12 %



Assessed against WHO Guidelines

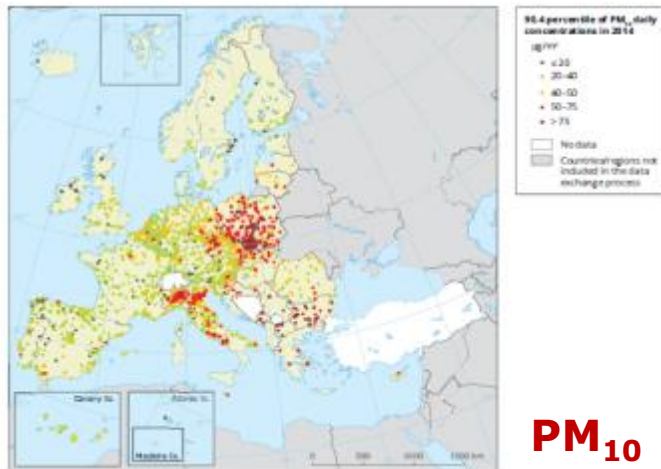
85-91 %



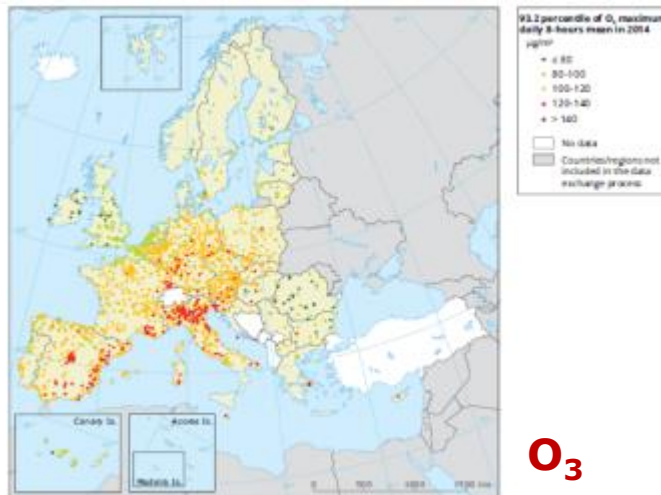
63%

Air pollution exceeds eutrophication limits in 63% of ecosystem area, and in 73% Natura2000 area.

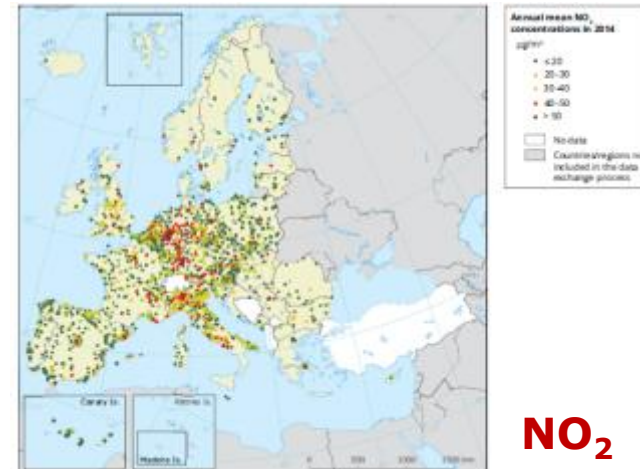
# Where air pollution is a problem



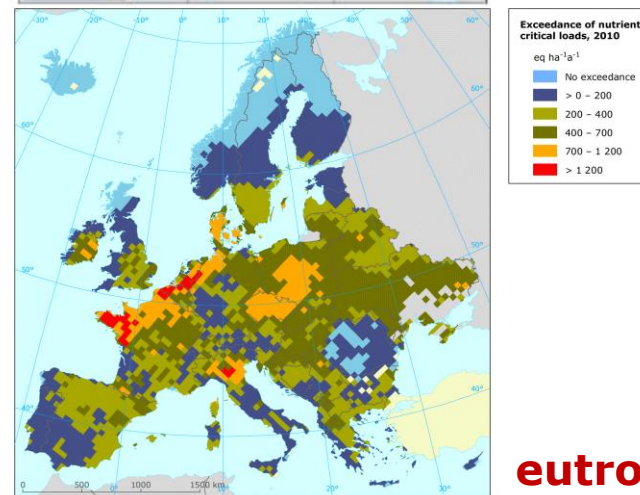
**$PM_{10}$**



**$O_3$**



**$NO_2$**



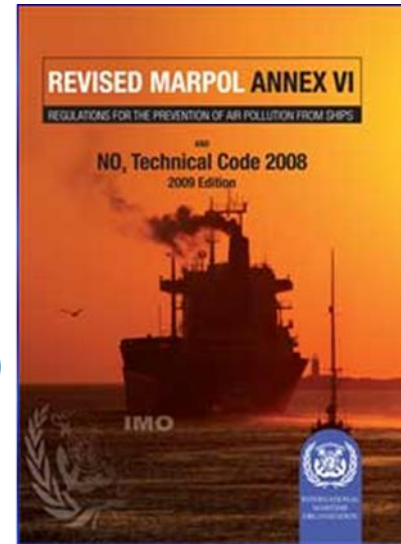
**eutrophication**



# MARPOL Annex VI



- **Adopted in 1997, entry into force in 2005**
- **Aiming at minimizing airborne emissions from ships**  
(SO<sub>x</sub>, NO<sub>x</sub>, ODS, VOC, CO<sub>2</sub>)
- **Revised Annex VI in October 2008, entry into force in July 2010**  
(with significant tighter emissions limits)
- **88 IMO Parties have so far ratified Annex VI (incl. 24 EU MS)**  
(96.66% of world merchant shipping tonnage)
- **Regulation 4 “Equivalents” - use of alternative compliance methods**  
(at least as effective in terms of emission reductions as required)





- **Revised MARPOL ANNEX VI - Resolution MEPC.175 (58), 2008**
  - Regulation 4, *on equivalency* - allows the use of alternative compliance methods at least as effective in terms of emission reductions as required
  - Regulation 13, *Nitrogen Oxides (NO<sub>x</sub>)*
- **NO<sub>x</sub> Technical Code 2008 - Resolution MEPC.177(58), 2008**
  - Certification, Testing and Measurement Procedures

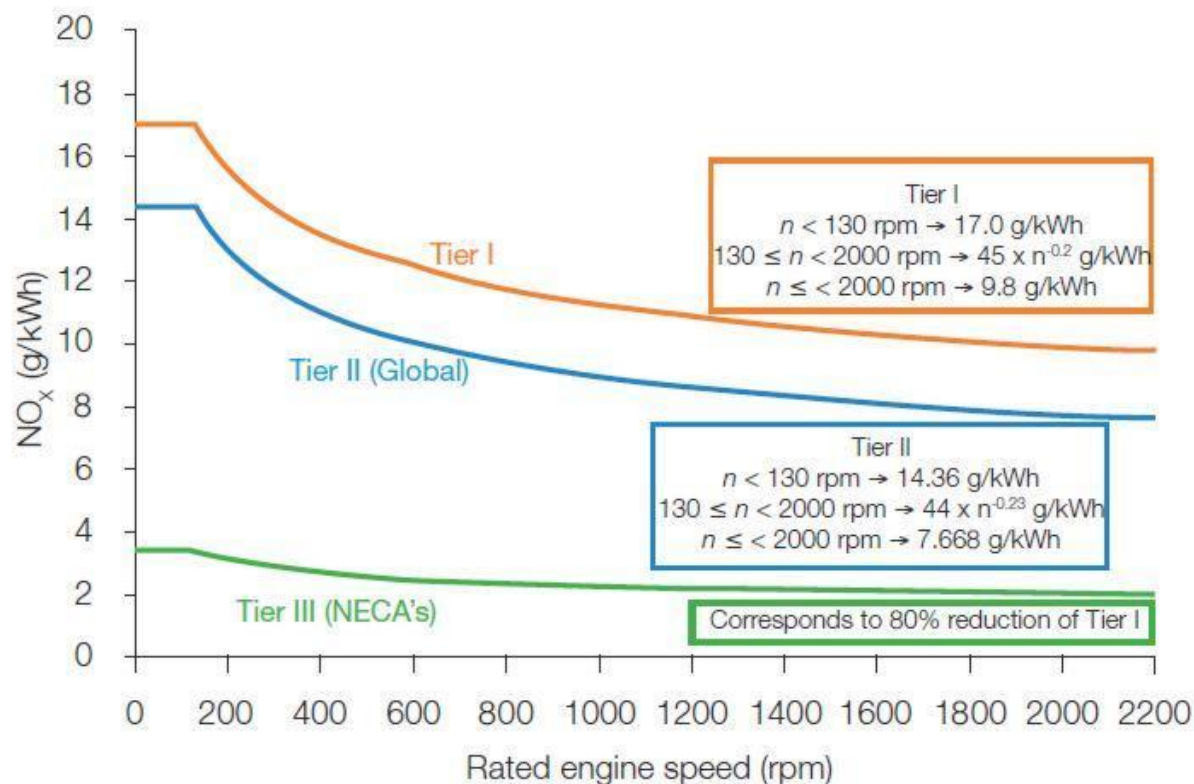
# MARPOL Annex VI - Regulation 13



- The NO<sub>x</sub> control requirements apply to marine diesel engines of over 130 kW
- Different levels (Tiers) of control apply based on the ship construction date (and speed)
- NO<sub>x</sub> global limits:
  - *Tier I on ships constructed on or after 1 January 2000 and prior to 1 January 2011*
  - *Tier II on ships constructed on or after 1 January 2011 and prior to 1 January 2016*
- NO<sub>x</sub> ECAs:
  - *Tier III on ships in NECAs constructed on or after 1 January 2016/1 January 2021*
- On ships built between 1 January 1990 to 1 January 2000, Tier I become applicable to certain existing engines installed subject to availability of an approved engine upgrade kit, engines with a displacement  $\geq 90$  liters per cylinder and rated output  $\geq 5,000$  kW.



# MARPOL Annex VI - Regulation 13



IMO NO<sub>x</sub> limits

## Effective Dates

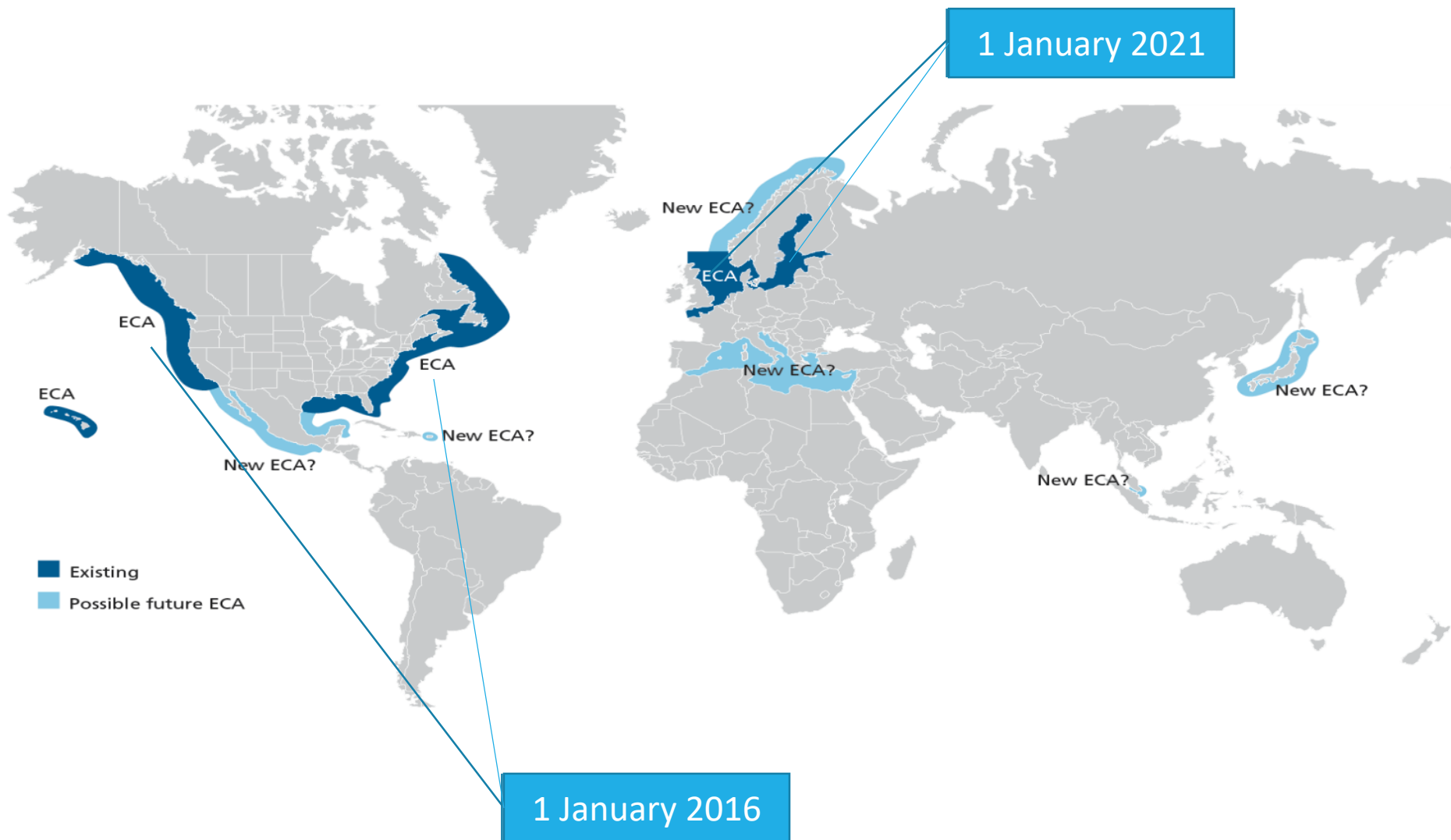
**Tier I - 1<sup>st</sup> Jan 2000**

**Tier II - 1<sup>st</sup> Jan 2011**

**Tier III - 1<sup>st</sup> Jan 2016**

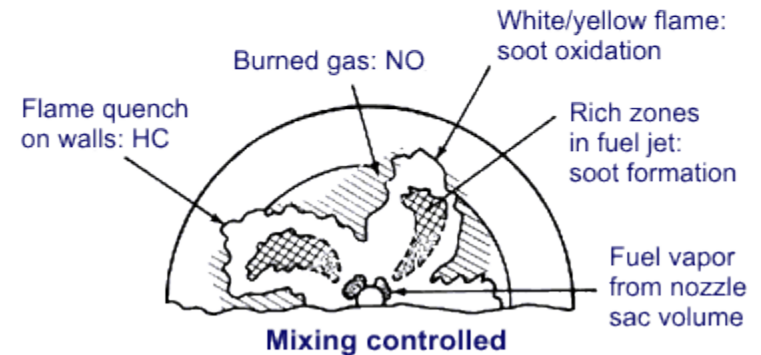
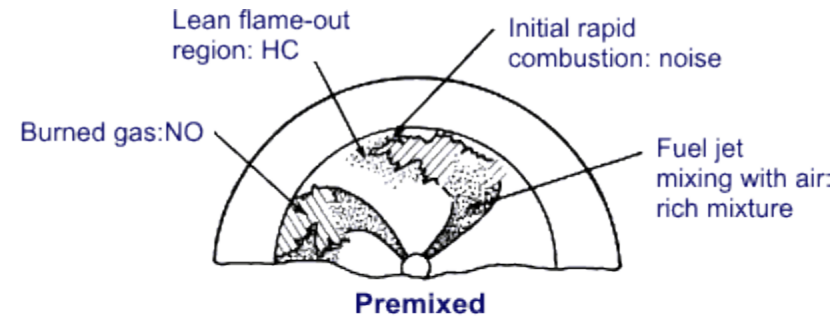
*Note: Tier III apply only to the specified ships while operating in NECA + subject to technical review*

# MARPOL – NECAs



# NO<sub>x</sub> formation

- Nitrogen (N) and Oxygen (O) are the precursors of NO<sub>x</sub> during the combustion process
- N and O comprise 99 % of the engine intake air
- O is mostly consumed in the combustion process
- A small % of N will be oxidized to form NO<sub>x</sub>
- The higher the combustion temperature, peak pressure, compression ratio, rate of fuel delivery, etc... the greater the amount of NO<sub>x</sub> formation.
- A slow-speed diesel engine, in general, tends to have more NO<sub>x</sub> formation than a high speed engine



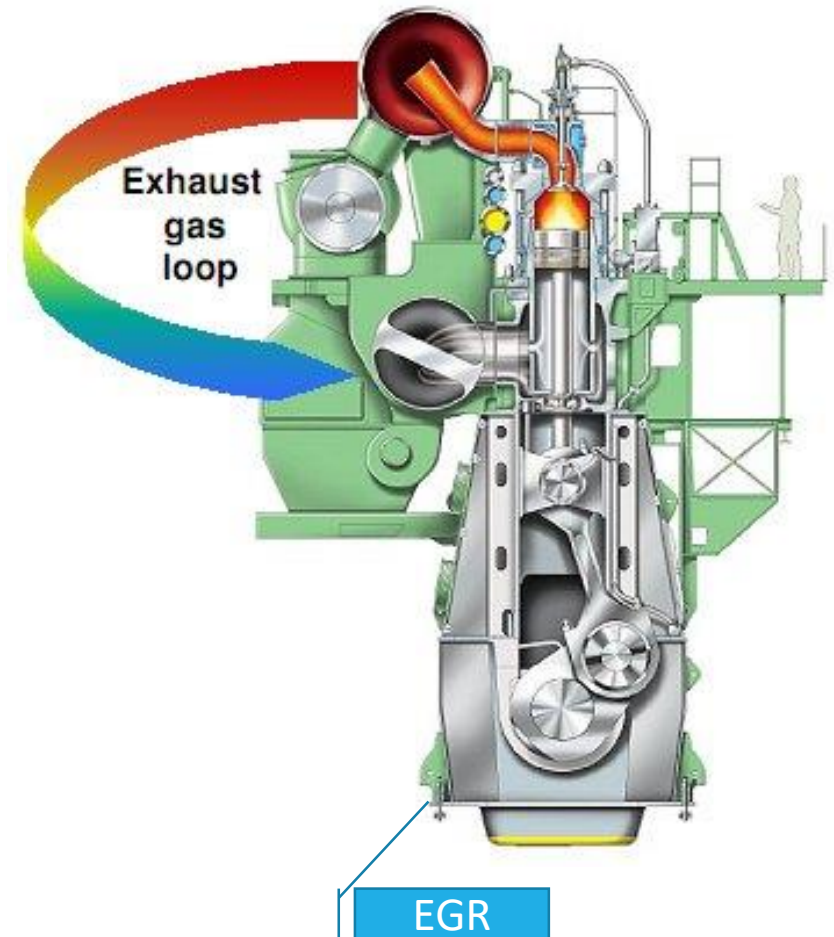
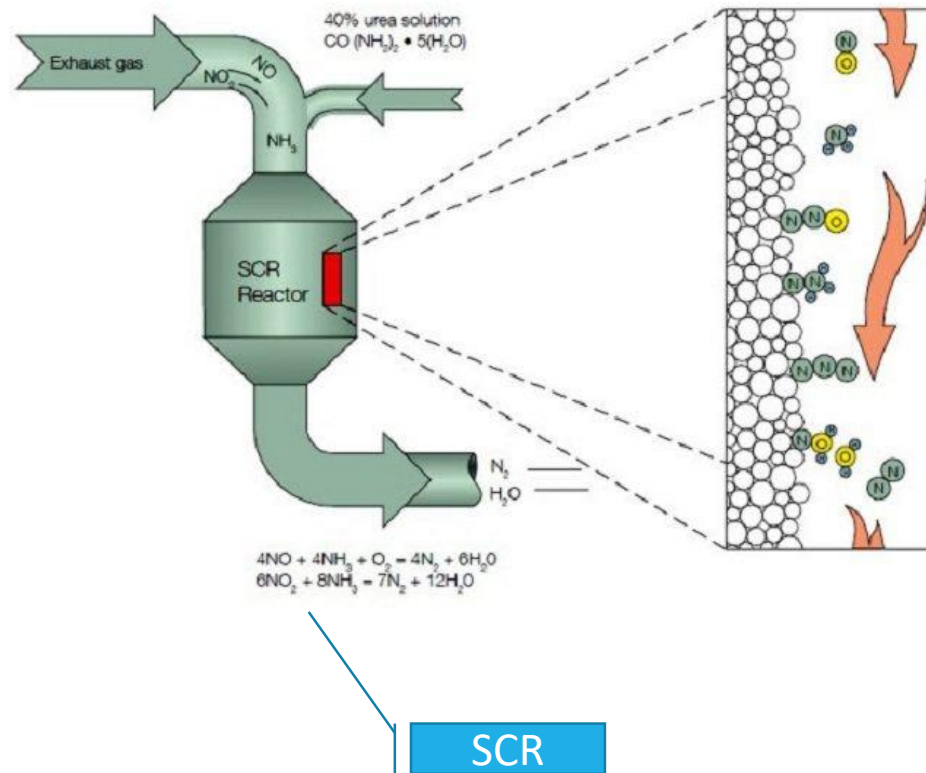
*Diesel combustion*

# Technical solutions to reduce NOx



- Tier I and Tier II standards can be met through the application of engine-based controls
- Tier III standards will require forcing “aftertreatment” for compliance or use of alternative fuels
- Tier II standards are generally met by combustion process optimization (fuel injection timing, pressure and rate, fuel nozzle flow area, exhaust valve timing and cylinder compression volume)
- Tier III standards require NOx emission control technologies such as various forms of water induction into the combustion process, exhaust gas recirculation or selective catalytic reduction

# Technical solutions to reduce NOx



# NOx Technical Code

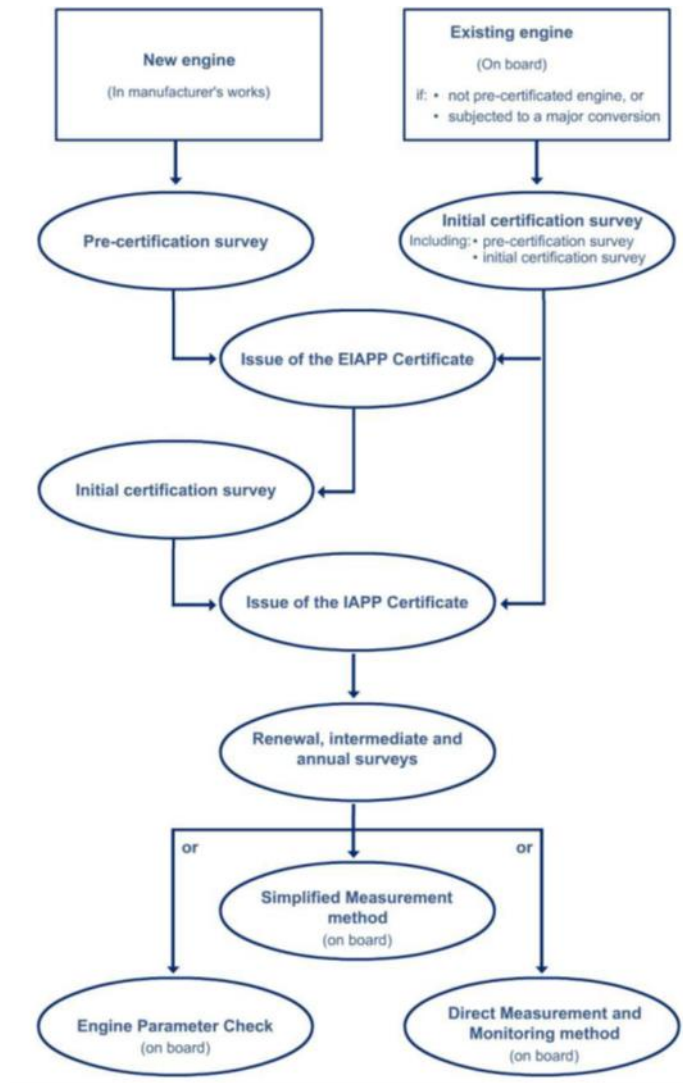
- In order to achieve the reduction of the NOx formation, the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (NOx Technical Code) was adopted on 26 September 1997.
- The NOx Technical Code, is to provide mandatory procedures for the testing, survey and certification of marine diesel engines in order to ensure that they comply with the relevant limiting emission values of NOx.
- The first version of the Code was published on 22 October 1997 (NOx Technical Code 1997), and applied to engines installed on ships constructed on or after 1 January 2000 (Res. 2 of MP\_CONF.3/35).
- The Code was subsequently amended on 10 October 2008 (NOx Technical Code 2008) and applies to engines installed on ships constructed on or after 1 January 2010 (IMO MEPC Res. 177(58)). Further amendments were adopted on 2012 (IMO Res MEPC.217/63) concerning certification of marine diesel engines fitted with selective catalytic reduction systems and not pre-certified on a test-bed.



# NOx Technical Code - Surveys & Certification

Each marine diesel engine to which the NOx Technical Code applies, shall be subject to the following surveys:

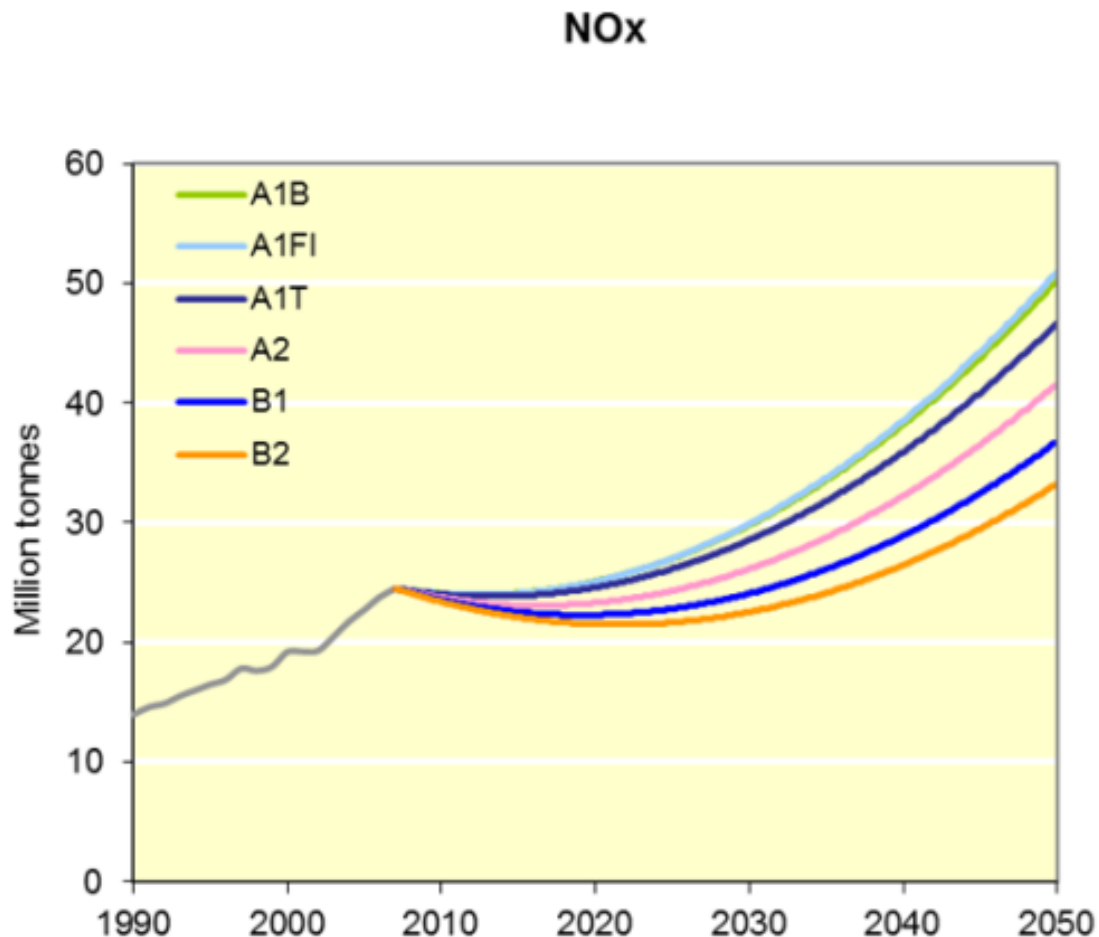
- Pre-certification survey
- Initial certification survey
- Renewal, intermediate and annual surveys



# NOx Technical Code - Surveys & Certification

- The **pre-certification survey**, verifies that the engine, as designed and equipped, complies with the applicable NOx emission limit
- After the pre-certification survey, an **Engine International Air Pollution Prevention (EIAPP) Certificate** is issued
- There are engines which, due to their size, construction and delivery schedule, cannot be pre-certified on a test-bed. In such cases, the engine manufacturer, shipowner or shipbuilder shall make application to the Administration requesting an onboard test
- After the engine is installed on board, but before it is placed in service, an **initial certification survey** shall be conducted on board the ship. This survey shall ensure that the engine, as installed on board the ship, including any modifications or adjustments since the pre-certification, complies with the applicable NOx emission limit.
- The **initial certification survey** is part of the ship's initial survey and may lead to either the issuance of the ship's initial **IAPP Certificate** or an amendment of the ship's valid IAPP Certificate reflecting the installation of a new engine.
- Renewal, annual and intermediate surveys shall be conducted to ensure the engines continue to comply fully with the provisions of the NOx Technical Code.

# NOx Ship Emissions Scenarios



*Emission Scenarios*  
*2008 revised Marpol Annex VI rules*  
*(2<sup>nd</sup> IMO GHG study 2009)*

# Thank you!

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