MARPOL Annex VI

Prevention of Air Pollution from Ships

Current regulations and the ongoing revision process

International Trends and Challenges

BY

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Sub-Division for Pollution Prevention

Marine Environment Division

INTERNATIONAL MARITIME ORGANIZATION

IMO – Background and structure

IMO instruments and method of work

MARPOL Annex VI

Air pollution from ships increases

Ongoing revision of MARPOL Annex VI, the NOx Technical Code and related guidelines

Questions

IMO – specialised UN agency

- **London headquarters**
- **Secretary General:**
  Admiral Efthimios Mitropoulos, Greece
- **Annual budget £24+ M**
- **Secretariat – 300 staff**
- **50 Nationalities**

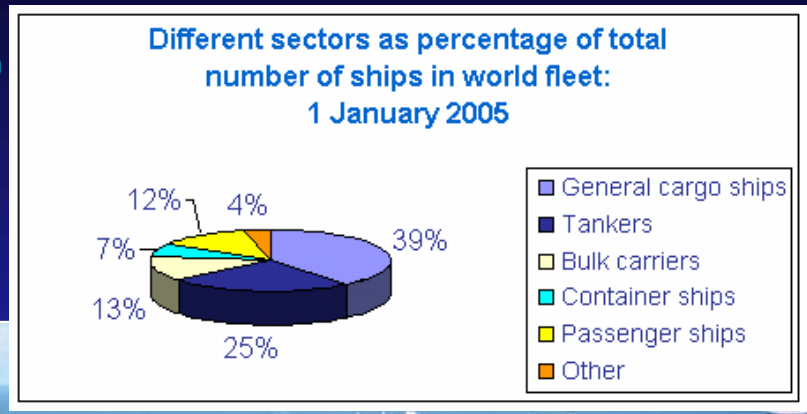
Safe, secure and efficient shipping on clean oceans!

IMO Convention

- **Adopted Geneva 1948**
- **Entered into force 1958**
- **First IMO meeting 1959**

The need for IMO

- **Shipping – international**
- **Underpins world trade**
- **Assets move between jurisdictions**
- **Universally applicable standards**



Early international treaties

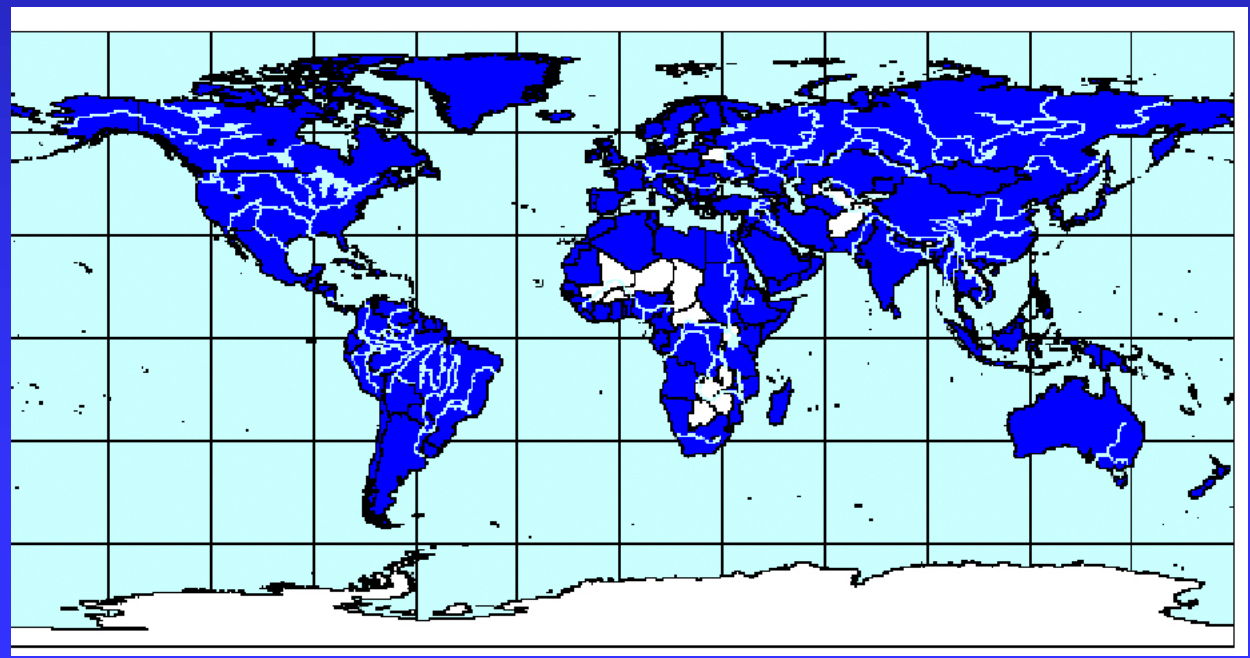
- **Mid – 19th Century**
- **1863 rules of the road – adopted by more than 30 countries**

First SOLAS Convention

- 1912 – Titanic disaster
- 1914 – First SOLAS Convention adopted
  - construction of ships
  - listening watch
  - lifeboats and lifejackets
- Revised and updated – still in force today
  - 98% of world fleet

Global coverage

- **166 Member States**
- **All major ship owning nations**
- **All major coastal states**
- **IGOs and NGOs**



Financed by shipping nations

Panama	£3.7m	19.1 %
Liberia	£1.5m	7.9%
Bahamas	£1.0m	5.2%
Greece	£0.86m	4.4%
Malta	£0.81m	4.2%
Japan	£0.79m	4.1%
UK	£0.74m	3.8%
USA	£0.70m	3.6%
Cyprus	£0.68m	3.5%
Norway	£0.68m	3.5%

Figures for 2005

IMO at work

- **Assembly**
- **Council**

- Committees:
  - **Maritime Safety**
  - **Marine Environment Protection**
  - **Legal**
  - **Technical Co-operation**
  - **Facilitation**

Sub committees

- Bulk Liquids and Gases
- Fire Protection
- Carriage of Dangerous Goods, Solid Cargoes and Containers
- Flag State Implementation
- Radiocommunications and Search and Rescue
- Safety of Navigation
- Ship Design and Equipment
- Stability, Load Lines and Fishing Vessel Safety
- Standards of Training and Watchkeeping

Progress of measures at IMO - example

Proposal to IMO Committee

Discussion, refer to Sub-Committee, Working Group

Development of draft Regulation, circular, Code or resolution

Adoption of new regulation

Application to real ships

- SOLAS 98.79% world tonnage
- Load lines 98.76%
- MARPOL 97.55%
- COLREGS 97.92%
- STCW 98.78%

Application to real ships

- More than 40 IMO Conventions
- Hundreds of codes, guidelines and recommendations
- Almost every aspect of shipping covered:
  - Design
  - Construction
  - Equipment
  - Maintenance
  - Crew

Safety and security

- **SOLAS**
- **STCW**
- **Load lines**
- **COLREGS**
- **SUA**

Photo taken by Swedish vessel Kbv202

Pollution prevention

- **MARPOL**
- **Dumping**
- **Intervention**
- **Anti-fouling**
- **Ballast water management**

Response and reaction

- SAR
- OPRC
- HNS Protocol

Liability and compensation

- **CLC**
- **IOPC Fund**
- **Athens**
- **Bunkers**
- **HNS**

Implementation – whose role?

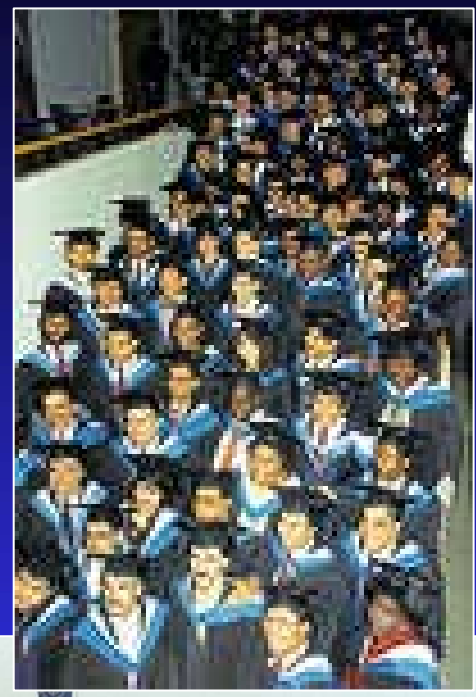
- **Flag States on own ship**
  - **classification societies**
  - **voluntary audit scheme**
    – first audits 2006

Port State Control

- **IMO – no "policing" mandate**

Technical co-operation

- **Resource imbalance**
- **Needs assessment**
- **Donors – expertise, funding, training**
- **World Maritime University**



Other key areas of IMO work:

Maritime security

- New maritime security measures adopted 2002 – in force July 2004

Bulk carriers

- Special chapter in SOLAS on bulk carrier safety adopted 1997

Passenger ships

- Many specific regulations for passenger ships and ro-ro ferries in response to major accidents

Other key areas of IMO work:

Fishing vessel safety

- Torremolinos Protocol 1993 and STCW-F 1995 still not in force
- 24,000 lives lost annually in fishing sector worldwide
- IMO/ILO/FAO:

- Code of Safety for Fishermen and Fishing Vessels, 2005
- Voluntary Guidelines for the Design, Construction and Equipment of Small Fishing Vessels, 2005

Other key areas of IMO work:

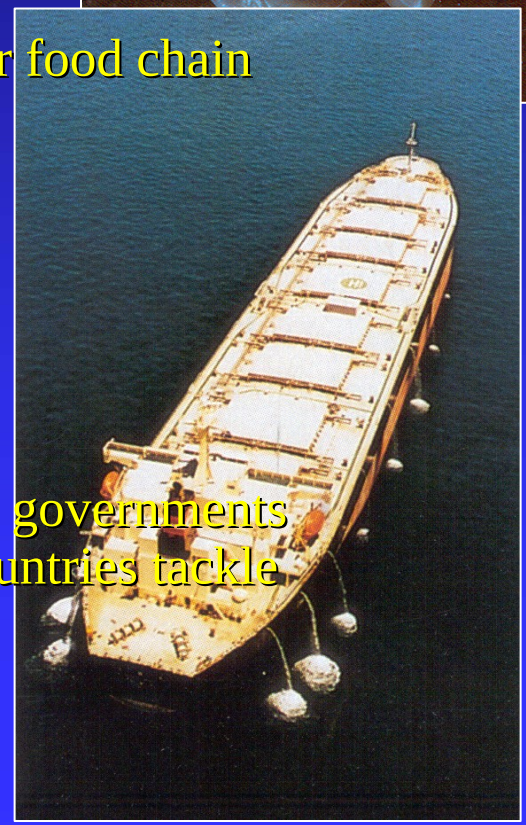
Facilitation of maritime traffic

- Facilitation (FAL) Convention adopted 1965
  - promote uniformity in formalities and procedures
  - harmonize documents required by shore authorities
  - prevent unnecessary delays in maritime traffic
  - aid co-operation between Governments
- Facilitation Committee
  - Ship-port interface working group
  - Stowaways
  - Migrants

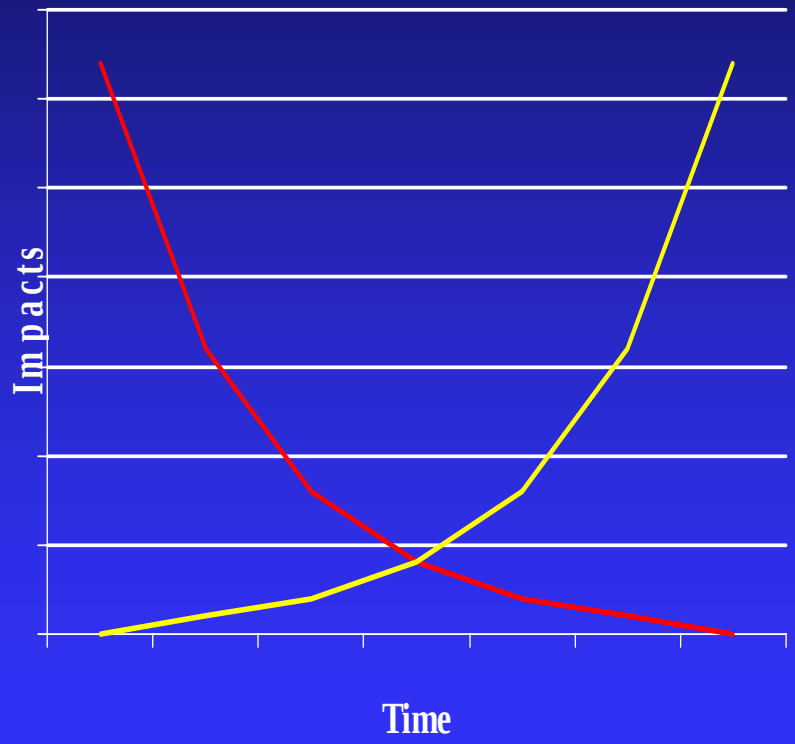
Other key areas of IMO work:

Ballast water

- The problem – brought to IMO in 1988
  - micro-organisms transported to alien eco-systems in ships' ballast water
  - no predators; environmental damage; enter food chain
- The solution
  - IMO Guidelines adopted 1997
  - technical advancements sought
  - new convention adopted 2004
- Globallast
  - Collaboration between IMO, GEF, UNDP, governments and industry to assist less-industrialised countries tackle ballast water problem



Impacts over time:
oil pollution vs marine bio-invasions



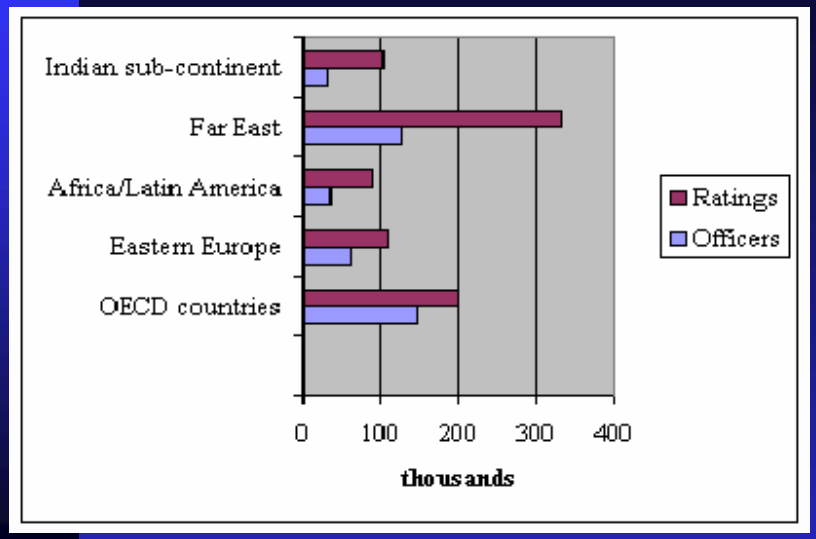
Other key areas of IMO work:

Ship recycling

- **Environmentally friendly disposal of old ships**
  - **Most components and materials re-used**
- **But: safety issues for workers**
  - **hazardous materials**
- **Guidelines adopted 2003**
  - **Address all stakeholders**
- **Inter-agency co-operation**
  - **ILO, Basel Convention**
- **Development of new legally-binding instrument by 2008/2009 biennium**

Other key areas of IMO work:

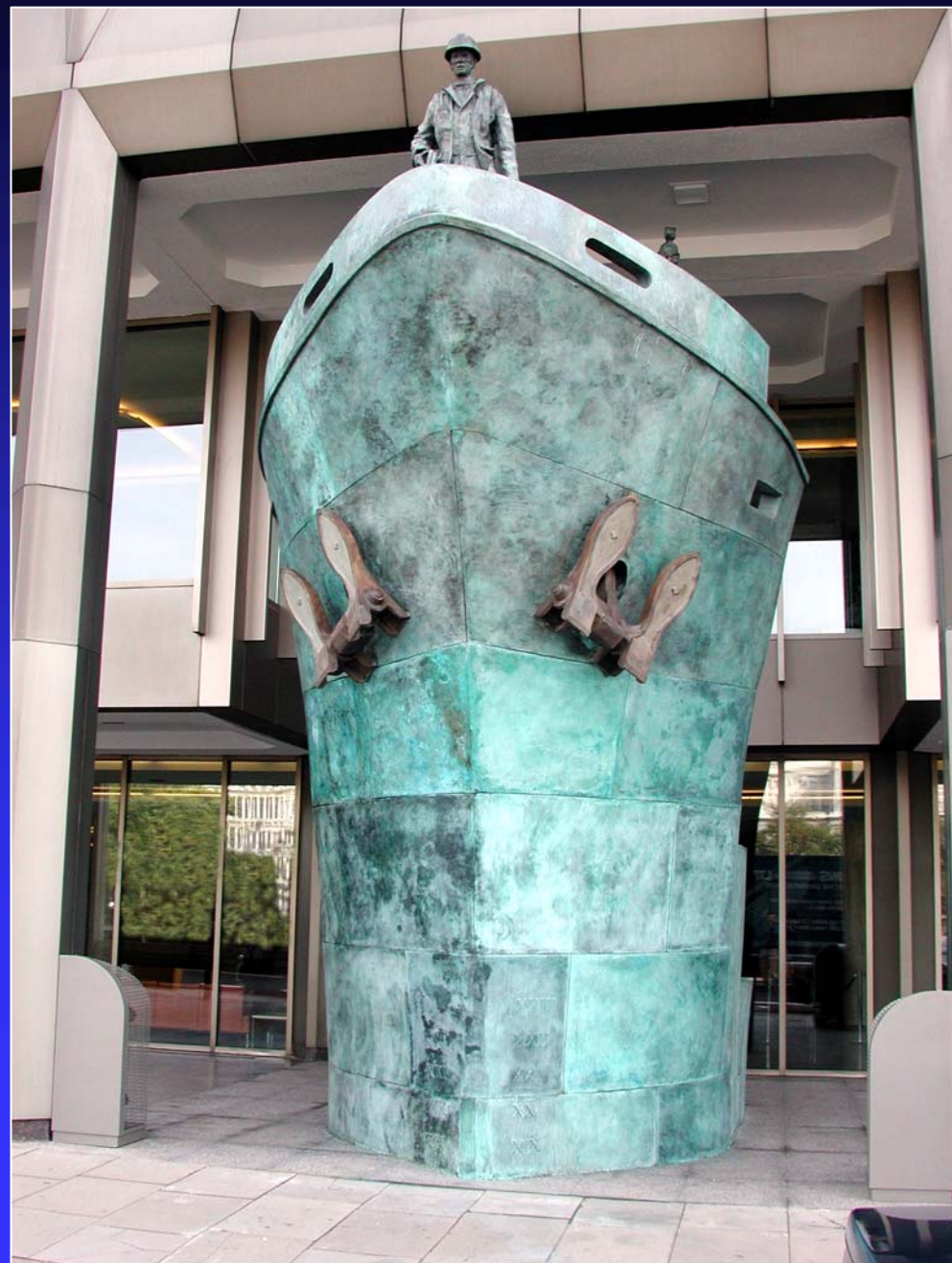
The human element



- STCW
  - Fully revised 1995
  - Emphasis on demonstrating competence
  - White List
- Fatigue
- Safe Manning Principles
- Seafarers' working hours – with ILO

Memorial to Seafarers

- Major work of sculpture
- Unveiled 2001
- Reminder to staff, delegates and visitors of seafarers' role



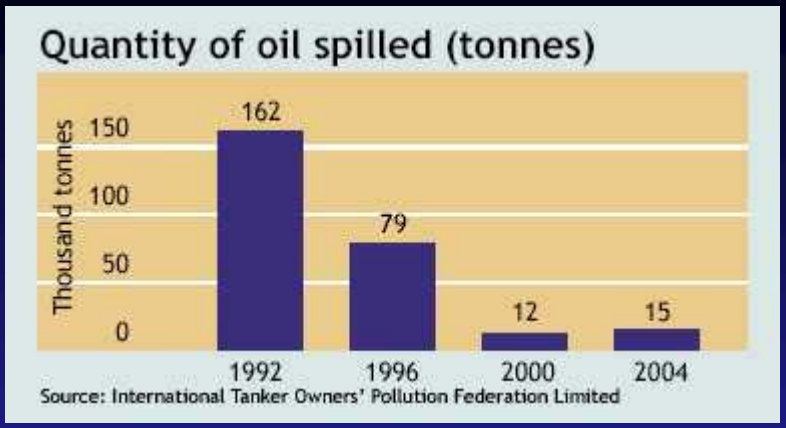
Does it work? – annual casualties

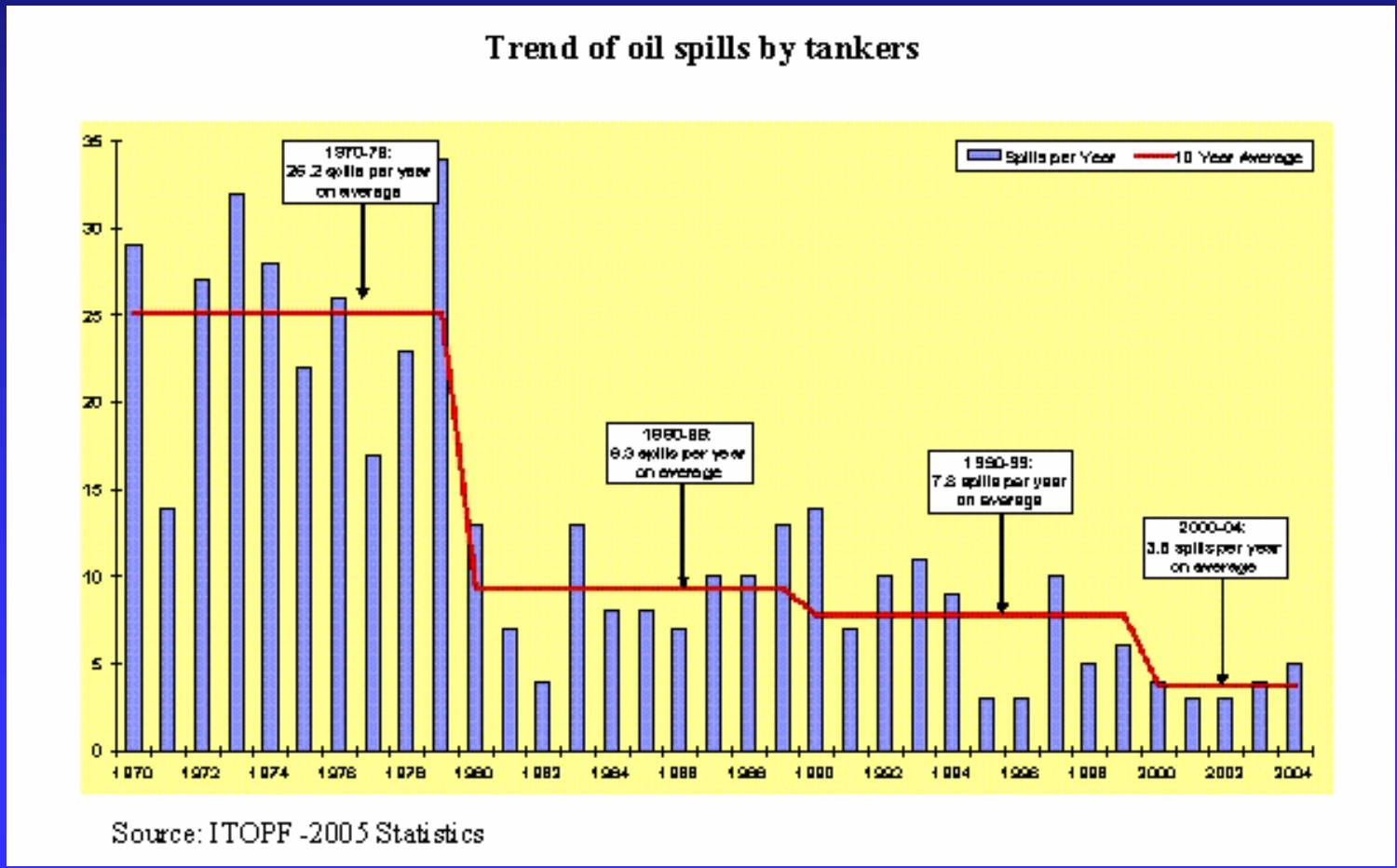
- 1966 to -85: more than 300 ships lost annually.
- (1978 and -79: 938 losses at 6.7 ships per ’000)
- 1959 (IMO starts working): vessels lost at 5 per ’000

- 1980: losses dip - downward curve ever since.
- 1990: losses under 200, at 2.4 per ’000 ships
- 2000: 167 losses at 1.9 per ’000 ships

Does it work?

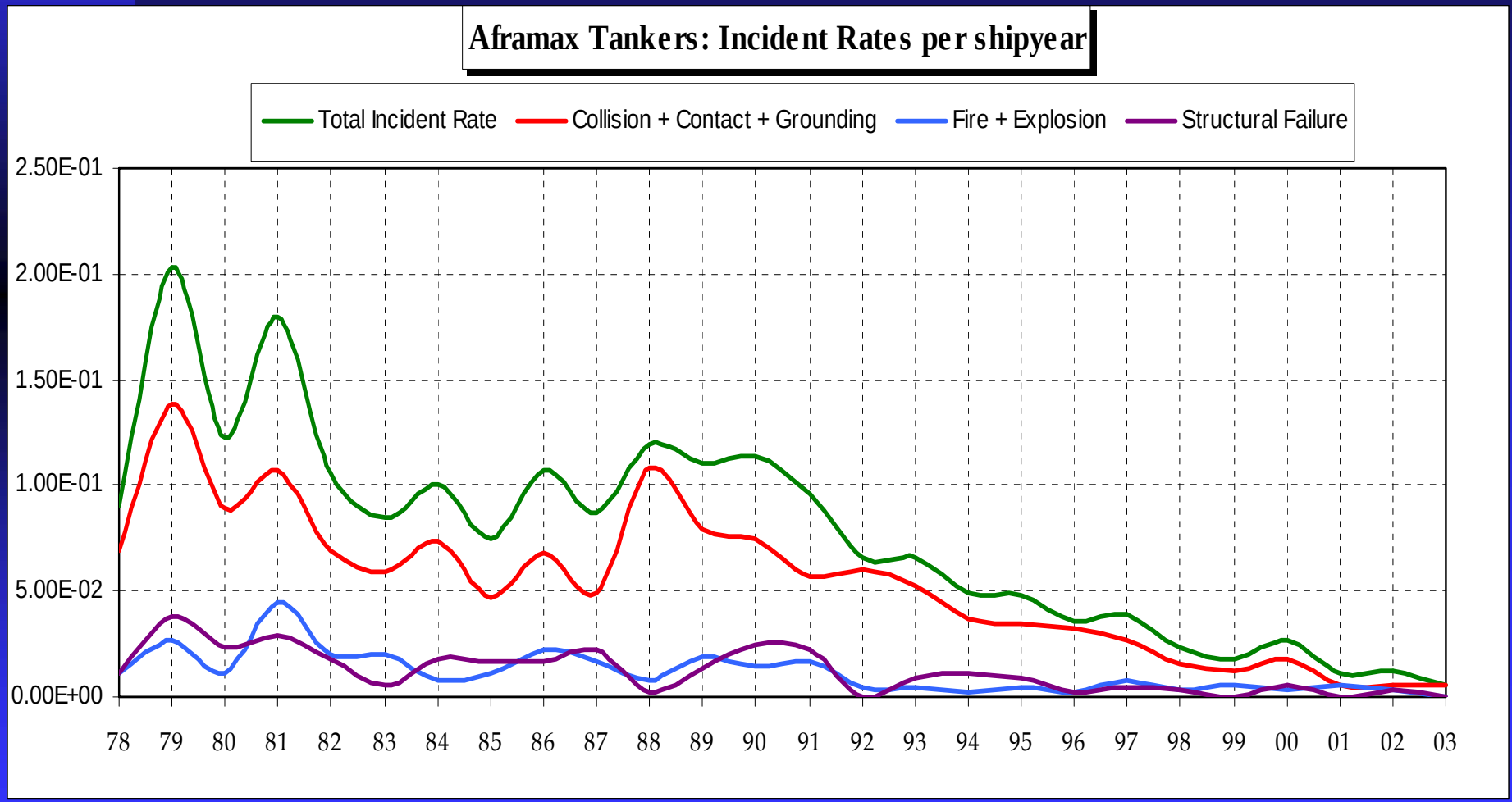
- Reduction in serious oil spills - ITOPF



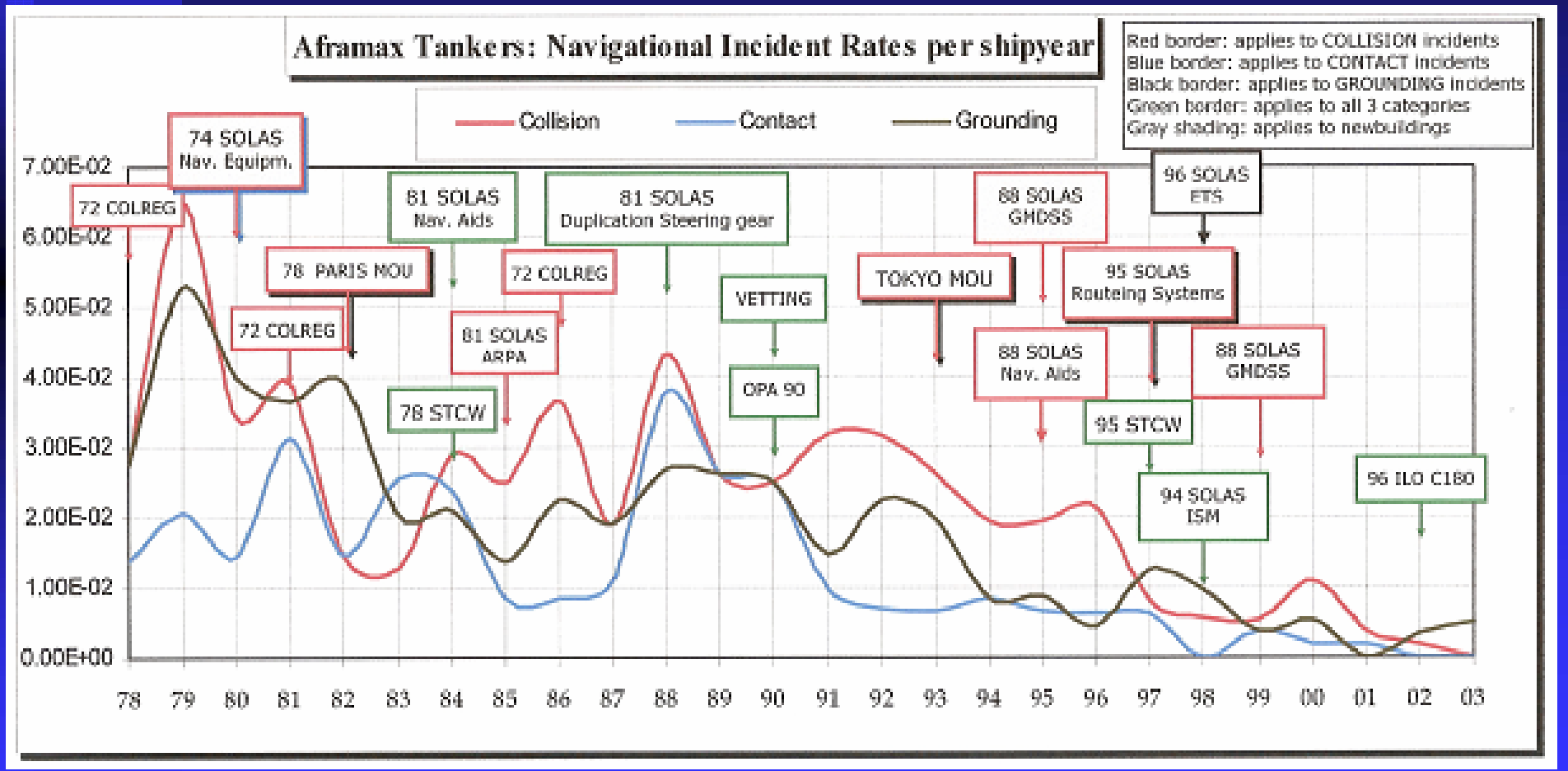


Aframax Tankers:

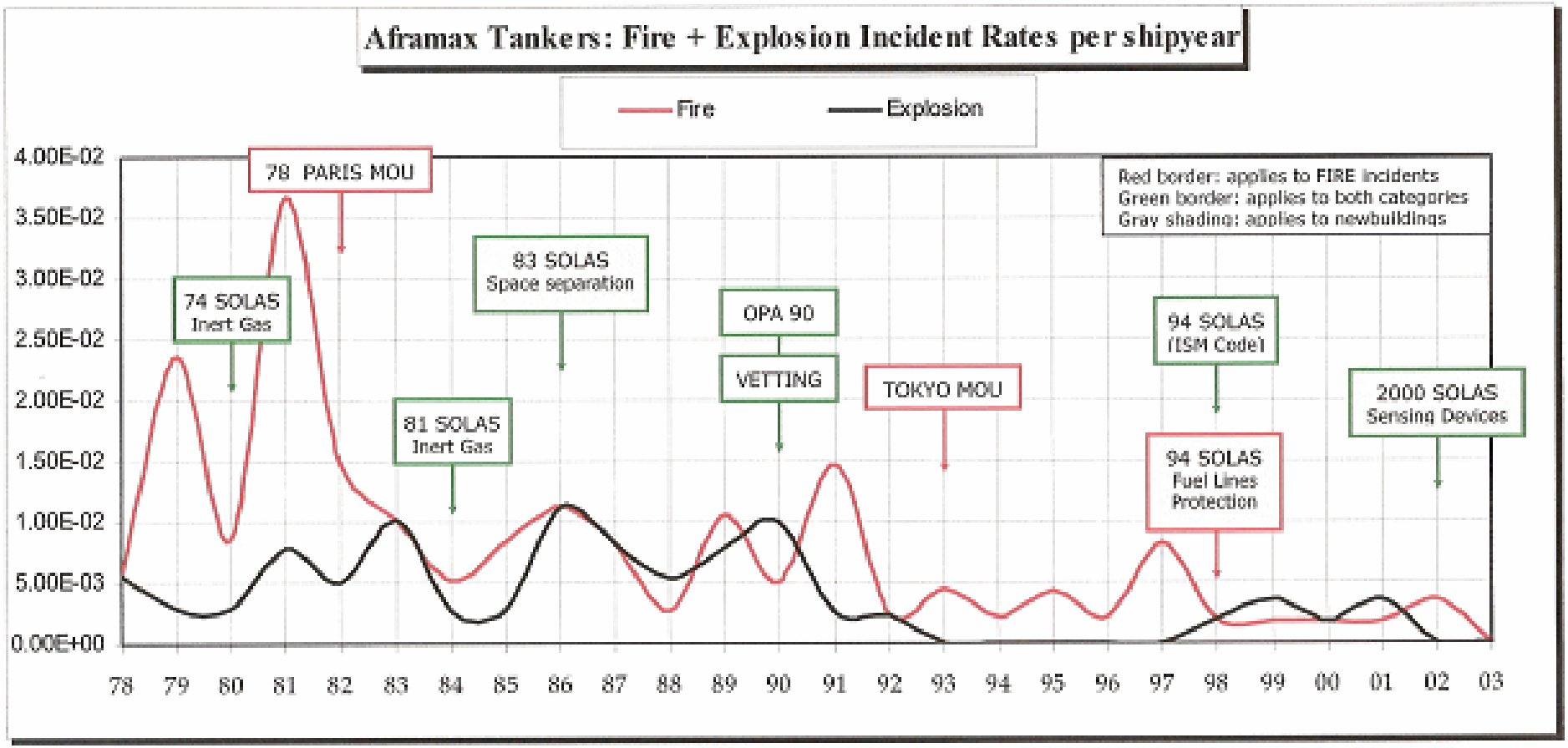
Incident Rates per Shipyear



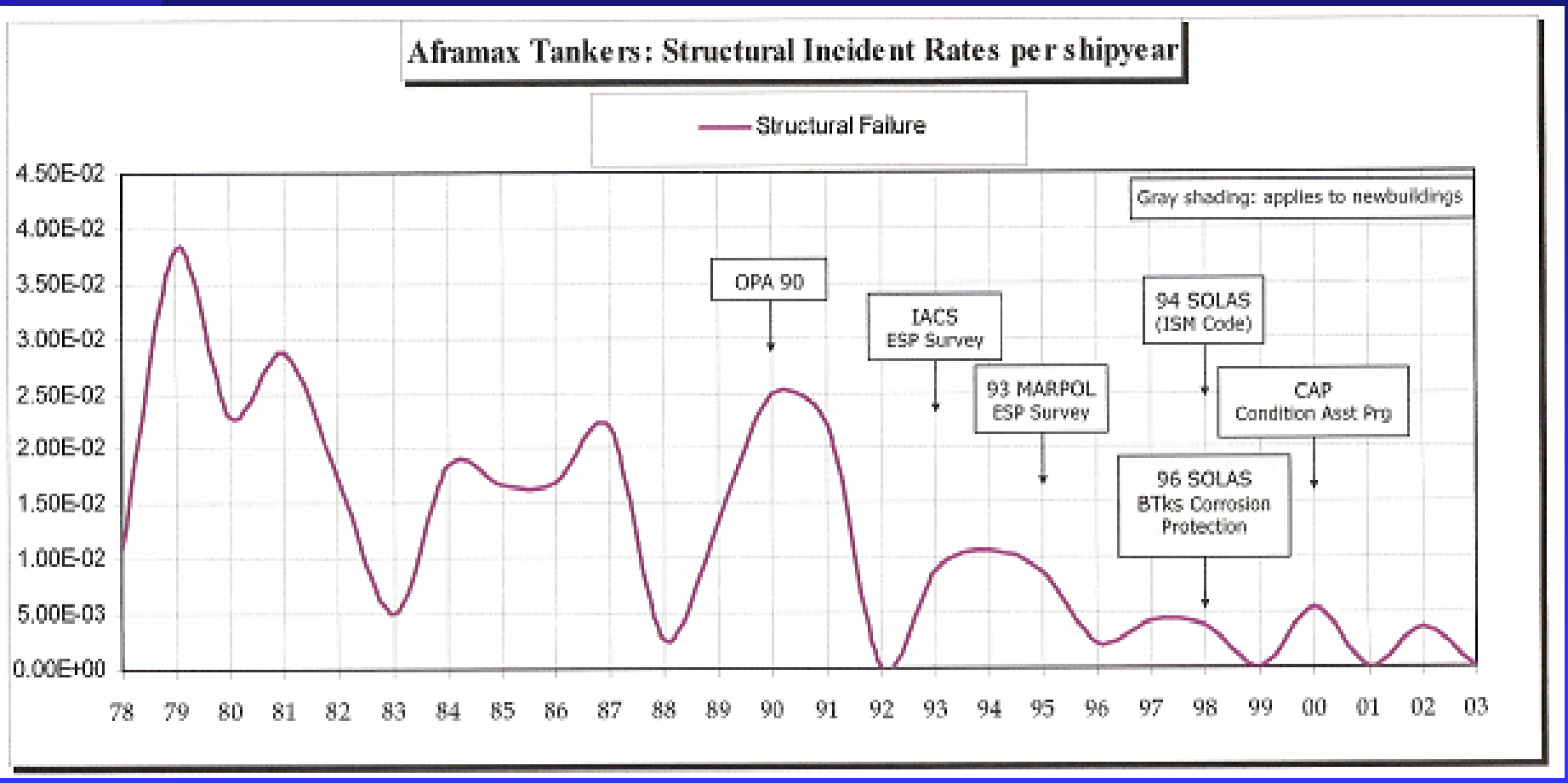
The regulatory effect



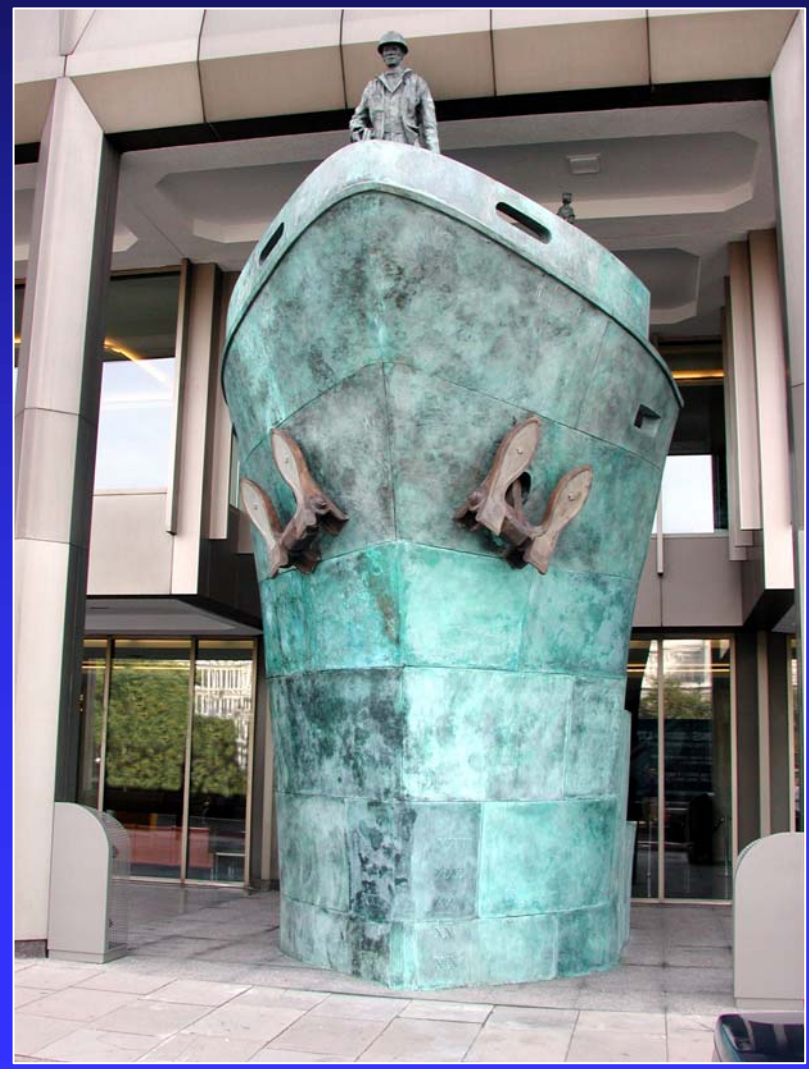
The regulatory effect



The regulatory effect

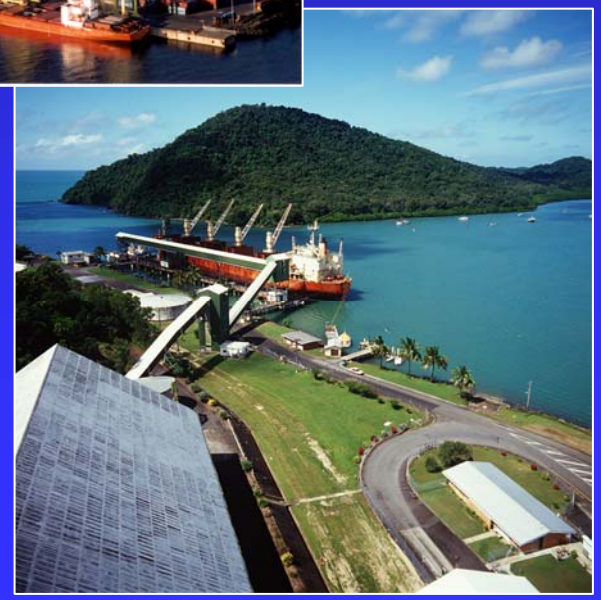


Technical excellence & human quality



Shipping affects us all!

- 90%+ of world trade are carried by sea
  - Raw materials and commodities
  - Finished goods
  - Foodstuffs
  - Fuel
- Underpins global economy
- Safe, secure and environmentally friendly transport system



The low costs of maritime transport

Due to continuous improvements in technology and efficiency maritime transport costs are very competitive.

- The typical cost to a consumer in the United States of transporting crude oil from the Middle East, in terms of the purchase price of gasoline at the pump, is about half a US cent per litre.

- The typical cost of transporting a tonne of iron ore from Australia to Europe by sea is about US $12.

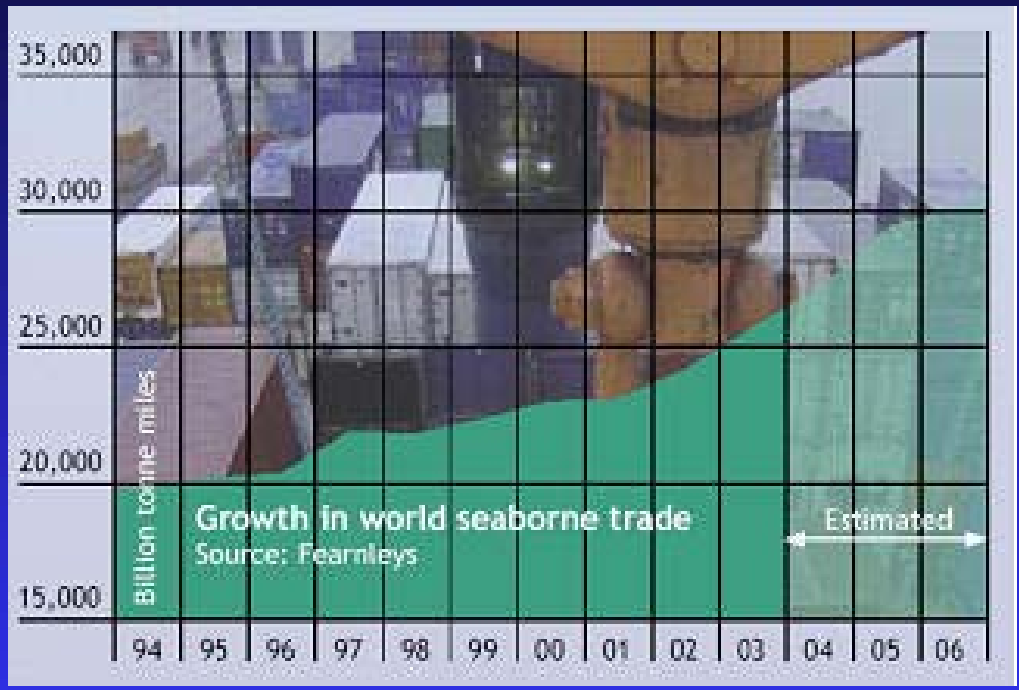
- The typical cost of transporting a 20 foot container from Asia to Europe carrying over 20 tonnes of cargo is about the same as the economy airfare for a single passenger on the same journey.

Typical Ocean Freight Costs (Asia-US or Asia-Europe)

	Unit	Typical Shelf Price	Shipping Costs
TV Set 	1 unit	$700.00	$10.00

 DVD/CD Player	1 unit	$200.00	$1.50
Vacuum Cleaner 	1 unit	$150.00	$1.00
Scotch Whisky 	Bottle	$50.00	$0.15
 Coffee	1 kg	$15.00	$0.15
 Biscuits	Tin	$3.00	$0.05
Beer 	Can	$1.00	$0.01

Low cost of sea transport is a major factor in the current globalisation and increase of world trade



An estimated doubling in container transport of manufactured goods by sea from 2004 to 2014 will also increase the transport of raw materials

Increase in world trade gives positive results for people in the developing world but also entails increased air pollution

Air pollution the last major ship pollutant to be regulated

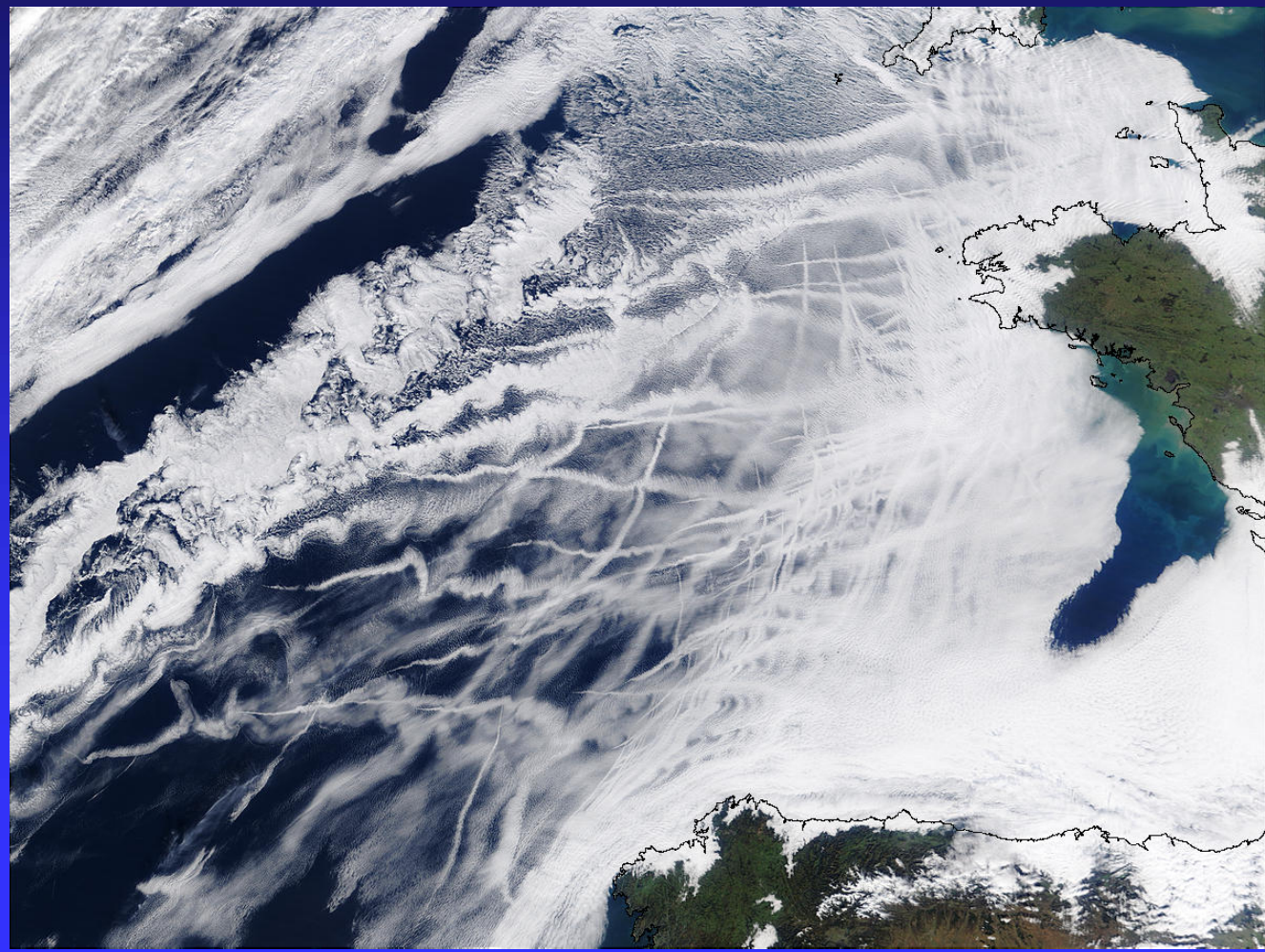
Work started at IMO in the 1980s

Adopted on 26 September 1997

Limits and regulations in Annex VI were set at very modest levels in order to be accepted

Applies to new engines only, manufacturers had no problems to meet the limits

Satellite image of ship tracks over Biscay (NASA, 2003)



MARPOL Annex VI – Prevention of Air Pollution from Ships

Protocol of 1997 (Annex VI) entered into force 19 May 2005

Ratified by 25 States, representing 50 % of the world tonnage

Only Parties to MARPOL 73/78 may become Parties

February 2006 ratified by 30 States / 63.73 % of the world tonnage

Emission means any release of substances subject to control by this Annex from ships into the atmosphere or the sea

Annex VI applies to all ships and to fixed and floating drilling rigs

Regulation 13 and the NOx technical code applies to diesel engines of 130 kW or more

MARPOL Annex VI – Prevention of Air Pollution from Ships

All ship of 400 GT or above engaged in voyages to ports or offshore terminals under the jurisdiction of other parties: Shall be subject to surveys (initial, intermediate, periodical) and an

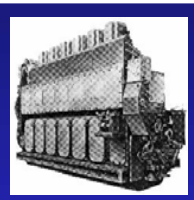
International Air Pollution Prevention Certificate

shall be issued by the Administration or a duly authorized body

Existing ships have to comply and be equipped with an IAPP Certificate at the **first scheduled drydocking** after entry into force, but in no case later than 3 years: **19 May 2008**

Procedure of Certification for MARPOL Annex VI

In Manufacturer's works



Pre-Certification Survey

↓

EIAPP-Certificate
+ Supplement
+ Technical File

On Shipyard

Initial Survey

↓

IAPP-Certificate

Maintaining of Compliance by

Intermediate Survey

Periodical Survey

Renewal of IAPP-Certificate

MARPOL Annex VI – Prevention of Air Pollution from Ships

Nitrogen Oxides' - NOx is formed during the combustion process

NOx emissions from marine diesel engines contribute to:

- Ground level ozone
- Particulate matter
- Eutrofication,
- Acid deposition,
- Nitrification.
- The indirect effect of NOx emissions to global warming should also be noted

MARPOL Annex VI – Prevention of Air Pollution from Ships

Regulation 13 of the 1997 Protocol contains limits for emissions of nitrogen oxides (NOx) from marine diesel engines. According to Regulation 13, the NOx emissions of any diesel engine with a power output of more than 130 kW installed on a ship constructed on or after 1 January 2000, or that undergoes a major conversion on or after that date, shall not exceed the following limits:

17 g/kW-hr	when *n* is less than 130 rpm
$45.0*n^{(-0.2)}$ g/kW-hr	when *n* is 130 or more but less than 2000 rpm
9.8 g/kW-hr	when *n* is 2000 rpm or more

MARPOL Annex VI – Prevention of Air Pollution from Ships

Sulphur is regulated by Regulation 14

No fuel oil on ships shall exceed 4,5 % m/m Sulphur

Within a SOx Emission Control Area (SECA) 1,5 %

Only two ways to prevent Sulphur pollution:

Use low sulphur fuel oil or scrub the exhaust gas!

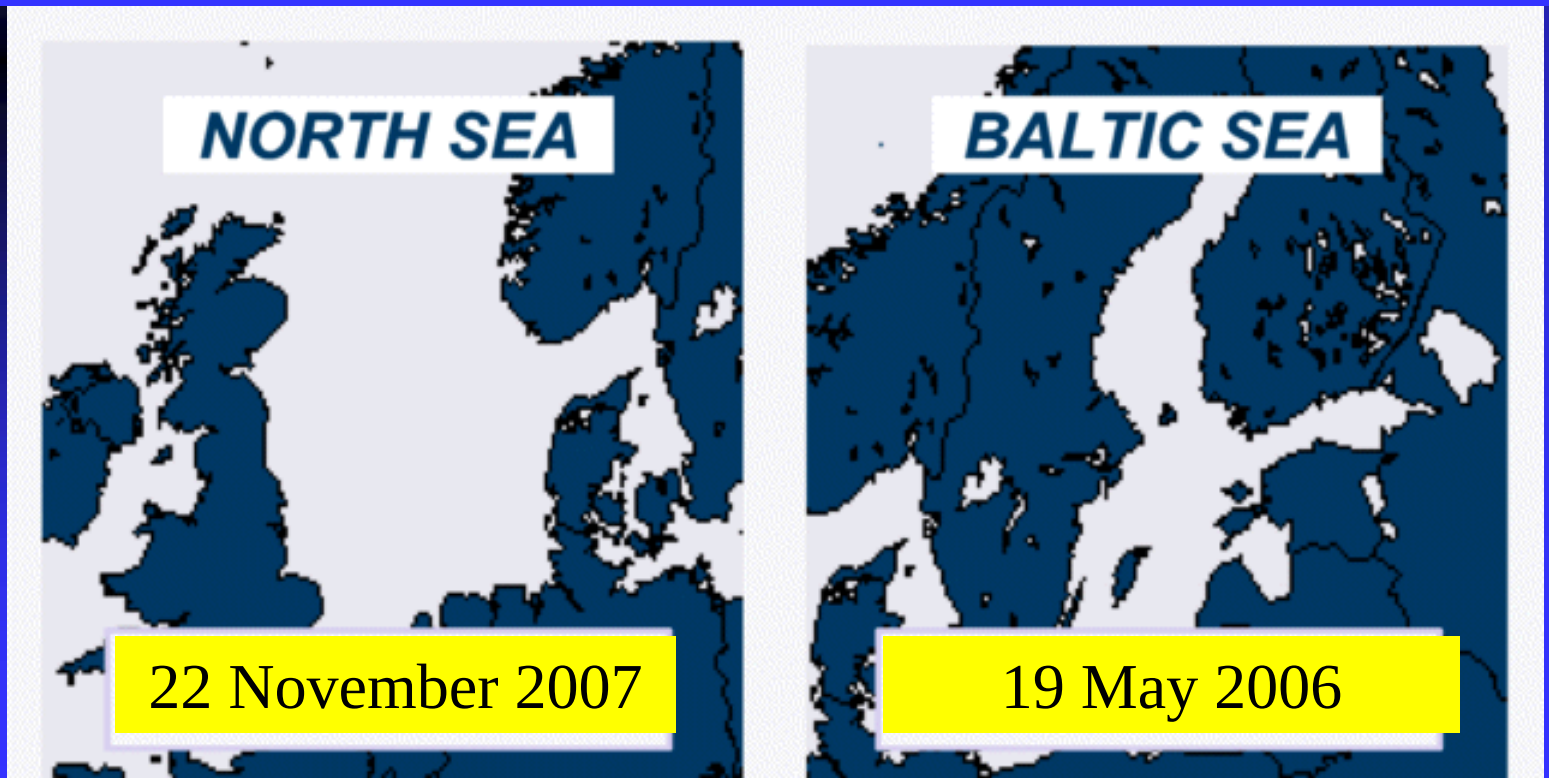
MEPC 53 adopted
Guidelines for:

EXHAUST GAS-SOx CLEANING SYSTEMS

MARPOL Annex VI – Prevention of Air Pollution from Ships

Sulphur Oxides Emission Control Areas (SECAs) may be designated by IMO in accordance with Appendix III

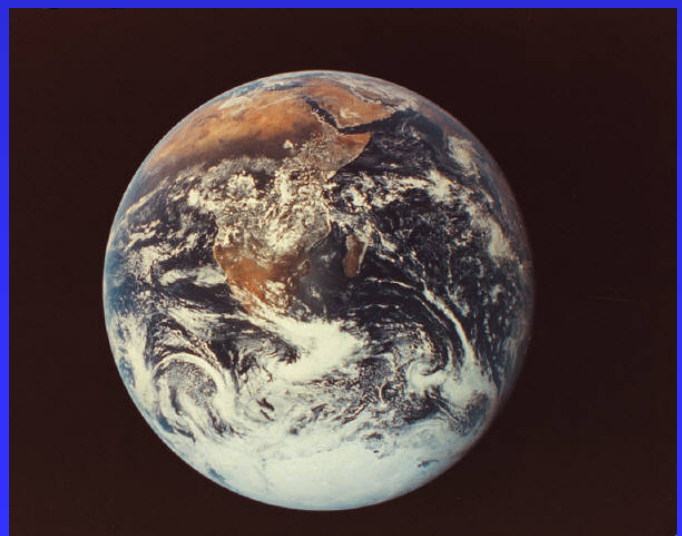
Within a SECA Sulphur content of fuel oil used shall not exceed 1,5 %, or the exhaust gas shall be scrubbed to reduce the total emission of SOx to 6.0 g SOx/kW hour or less



New SECAs may be established in accordance with Appendix III of Annex VI

Procedures as an amendment, considered, adopted and brought into force in accordance with Article 16, which means 16 months from adoption to entering into force, and another 12 months (reg. 14(7))before it can be enforced

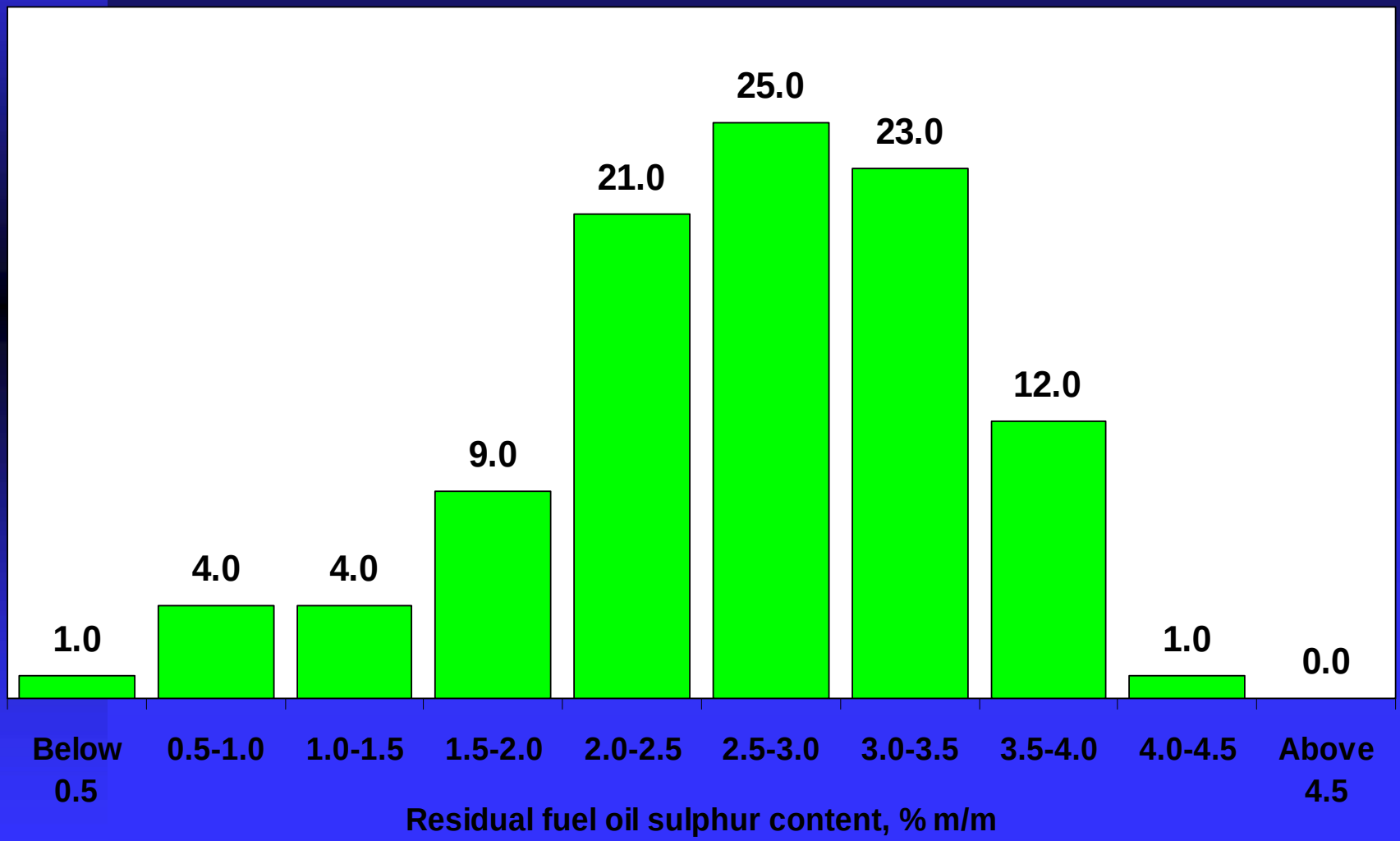
Shall take into account the relative cost of reducing sulphur depositions from ships when compared with land-based controls, and also the economic impacts on shipping



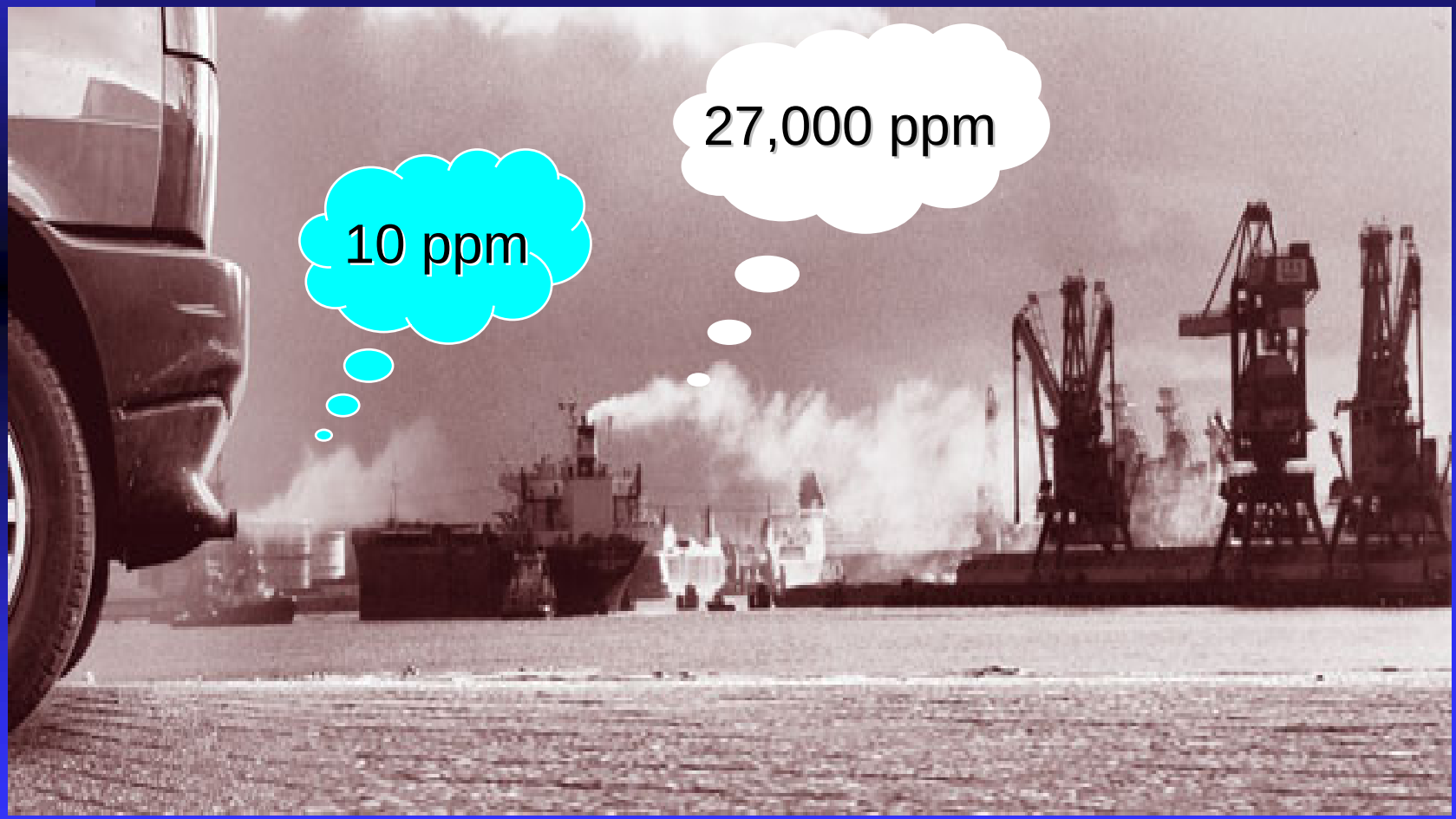
No current proposals for designation of any new SECAs

Sulphur Monitoring Program

Established 1999 - World average: 2.7 %



Ship fuel sulphur content - Large room for improvement



Appendix V

Information to be included in the bunker delivery note (Regulation 18(3))

Name and IMO number of receiving ship

Port

Date of commencement of delivery

Name, address, and telephone number of marine fuel oil supplier

Product names)

Quantity (metric tons)

Density at 15°C (kg/m3)

Sulphur content (% m/m)

A declaration signed and certified by the fuel oil supplier's representative that the fuel oil supplied is in conformity with regulation 14 (1) or (4)(a) and regulation 18(1)

MARPOL Annex VI – Prevention of Air Pollution from Ships

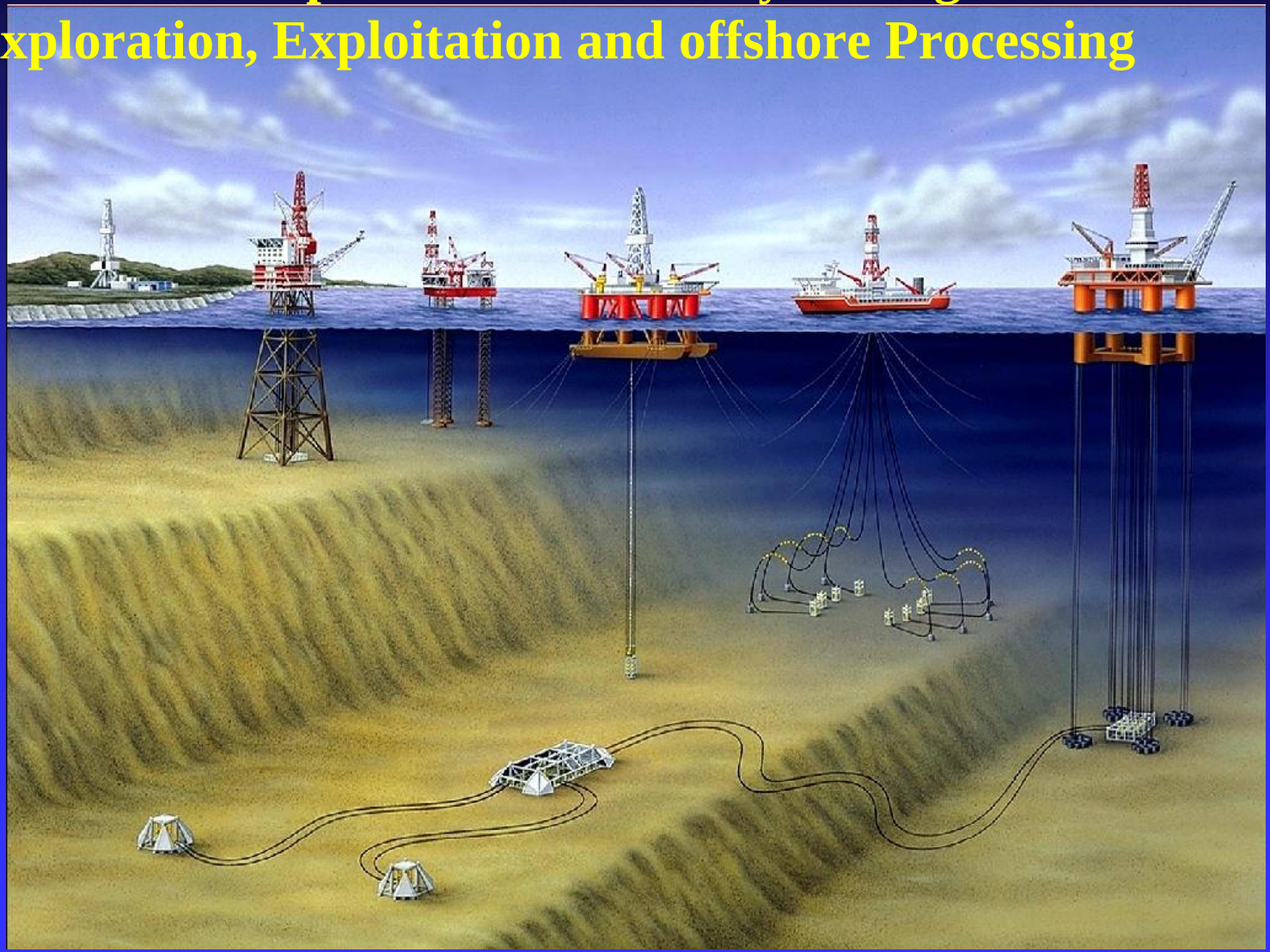
Volatile Organic Compounds – VOC – Regulation 15

VOC is the mixture of light end components (methane to octane) in crude oil, emitted from the oil during production, processing, loading, transport, unloading and storage.

To be regulated Nationally in accordance with Reg 15

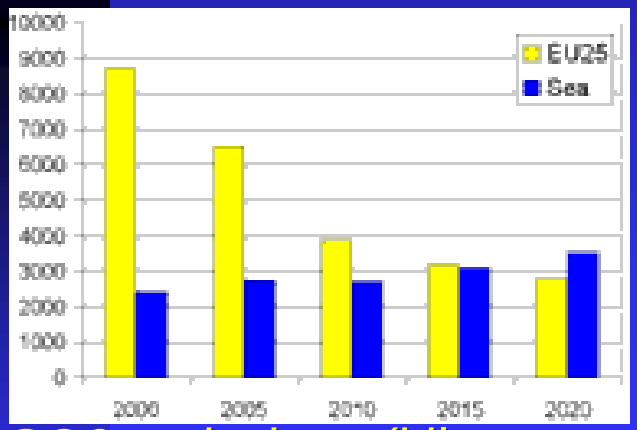
The lightest component (mainly methane) contributes to the greenhouse effect, whilst the heavier components (mainly propane and butane) contribute to ground level ozone, detrimental to human health and the vegetation. VOC can also be the direct cause of oil spill on the ship's deck, as high flow out of the cargo tanks/ riser mast due to severe VOC generation can cause oil entrainment into the inert/ VOC flow.

MARPOL Annex VI – Prevention of Air Pollution from Ships also applies to every fixed and floating drilling rigs and other platforms – except emissions directly arising from the Exploration, Exploitation and offshore Processing

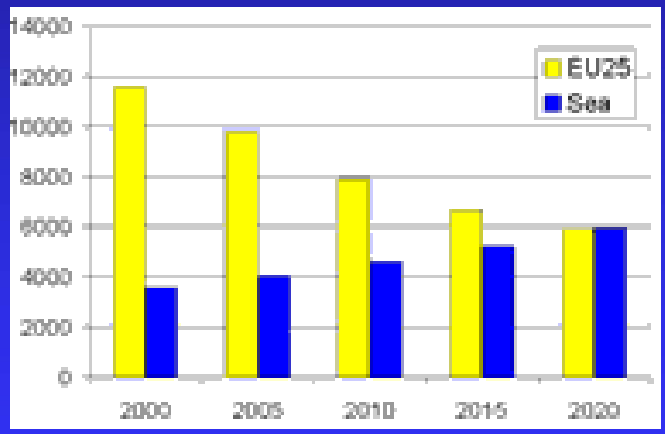


Ship emissions growing and becoming more conspicuous

- As land-based sources of emissions are abated and stringently regulated, eg power plants & road transport, ship emissions grow
  - In total volume: EU ship SO_2 and NOx currently c 80% of all land sources combined, by 2020: 100x more SO_2 than from aviation.



SO2 emissions (kilotonnes)



NOx emissions (kilotonnes)

- Per t/km: ships emit 50x more SO2 and slightly more NOx than new trucks
- Impact of emissions depends on location; modelling shows they contribute 90% of acid excess in N Europe, 15-30% particles in all coastal areas
- Spending €28m reducing ship NOx could save EU land industry €150m…

MARPOL Annex VI – Prevention of Air Pollution from Ships

It is widely acknowledged that technology improvements now exist that will enable significant improvement over existing standards in Annex VI.

Leading manufacturers have revealed that significant emission improvements can be achieved in engines made before 2000 through valve upgrades and other routine maintenance.

After entering into force a string of difficulties in implementing and enforcing the regulations have occurred, proposals for more than 70 unified interpretations

Therefore MEPC 53 decided to review Annex VI

- New studies shows that many abatement technologies are available, and cost-effective compared to land
  - **Slide valves** reduce NOx on slow-speed engines by 20%, very cheap, easy to fit & cost-effective (from €9 / tonne)
  - **In-engine controls** could cut new engine NOx by 30%
  - **Water Injection / Humid Air Motor** cut 50% / 75%
  - **Sea-water scrubbing** cuts SO_2 by 75%, also some PM
  - **Selective Catalytic Reduction** cuts NOx by 90%
- EU study will be made available to IMO to inform Annex VI review process

Terms of Reference for the revision of Annex VI

1 Examine available and developing techniques for reduction of emission of air pollutants;

2 Review the relevant technologies and potential for reduction of NOx, and recommend future limits of NOx emission;

3 Review technology and the need for reduction of SOx, justify and recommend future limits of SOx emission;

4 Review relevant technology and the need and potential for reduction of VOC, and recommend future control of VOC emission;

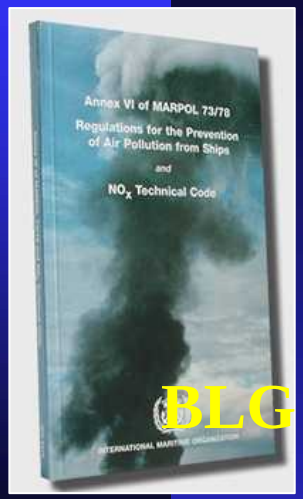
5 With a view to controlling emissions of particulate matter (PM), study current emission levels of PM from marine engines, including their size distribution, quantity, and recommend actions to be taken for the reduction of PM from ships. Since reduction of NOx and SOx emission is expected to also reduce PM emission, estimate the level of PM emission reduction through this route;

6 Consider reducing NOx and PM limits for existing engines;

7 Consider whether Annex VI emission reductions or limitations should be expanded to include diesel engines that use alternative fuels and engine systems/power plants other than diesel engines; and

8 Review the texts of Annex VI, NOx Technical Code and related guidelines and recommend necessary amendments;

Revision of Annex VI, the NOx Code and related Guidelines



The task is delegated to the Sub-Committee for

Bulk Liquids and Gases – BLG

With target completion date of 2007

BLG 10 from 3 – 7 April this year started the work with more than 30 documents to consider

A Working Group on Air Pollution was established under the chairmanship of Mr. Bryan Wood-Thomas, USA

The essential purpose of deliberations during this session was to begin a dialogue on the basic factual and structural issues that will enable Member States and organizations to better formulate their views on what amendments may be appropriate and how to best structure any new standards developed as a result of the present review

NOx reduction for new engines

The WG agreed to investigate and develop further 3 tier approach, where the current level in regulation 13 should be considered as tier 1.
Tier 2 should represent the best current available technology with a possible target date on entry into force in 2010.
Tier 3 should represent strict emission limits only possible to meet today's technology in an early stage that requires further R & D for reliable and safe operations under all circumstances.
Tier 3 may enter into force between 2014 and 2015. The Tier 3 limits should be retrieved in light of available technology in 2012, but the limits should be set now as an incentive for engine manufacturers and predictability for the ship owners and the shipping industry.

NOx reduction for existing engines

The working group considered the possibility of achieving significant emission reductions in existing engines through changes in injector systems and valve configurations. Most members expressed support for considering standards applicable to existing engines due to the emission benefits to be achieved in the short run. The working group emphasized that any standard to be adopted for existing engines would require substantial modifications that would necessitate certification. It was further noted that modifications on existing engines would likely impact the ships' propulsion efficiency which may result in an increase of fuel consumption. To avoid this, ships might need to redesign and change their propeller, thereby increasing the costs associated with the change.

Marine engines for recreational use

A brief discussion was held regarding the difference in operating hours between recreational and commercial marine engines, but the group did not express any opinion on whether any delineation of standards between recreational and commercial engines offered any particular value in defining future Tier II or Tier III standards.

Future Sulphur limits

The working group considered the question of whether the global sulphur cap limits within SECAs should be lowered in light of the role that sulphur content plays in sulphate and particulate formation and the consequent human health risks and environmental issues. The group noted that further reductions in sulphur limits or the designation of additional SECAs will effectively require the use of exhaust gas cleaning technology (e.g. SOx scrubbers) or distillate fuel since the availability of low-sulphur residual fuel oil is limited and it is not realistic to expect that the refining industry will convert high-sulphur fuel into low-sulphur residual fuel. The working group noted that various studies are underway in Europe, the United States, and other areas that may offer further insight into this issue in the near future.

Particulate matter - PM

The working group considered the growing concern associated with the effect of PM on human health, especially secondary particulates that are associated with smaller particulate matter. The Group noted that particulate formation is largely a function of the fuel quality used and that the use of cleaner fuels (low sulphur) is one of the most direct means of achieving particulate reduction. The working group also noted that exhaust gas cleaning can provide significant reductions as well, while some engine technologies offer limited benefits. The Group also noted that further discussion will be necessary, and agreed to strongly encourage submissions to the forthcoming intersessional meeting concerning relevant research and modelling studies concerning particulate matter generated by ships as well as the fate and transport of ship-generated PM.

VOC emissions

The working group discussed the possibility of reducing VOC emissions by introducing a requirement for a VOC management plan in regulation 15 of Annex VI and agreed that this should be further developed. The group noted that reducing emissions by improving operational procedures is likely to be cost effective on a general basis. The precise cost effectiveness is difficult to characterize since the result would vary according to the specific operating practices employed on a given vessel.

Revision of Annex VI, the NOx Code and related Guidelines

Progress

MEPC 53 in July 2005 agreed to the revision

BLG 10 in April 2006 started the work

Two intersessional correspondence groups established

Intersessional meeting in the Working Group in Norway 13 – 17 November 2006

Possible intersessional correspondence group(s)

BLG 11 in April 2007 to finalize draft proposals for revised Annex VI, the NOx Code and related Guidelines

MEPC 56 in July 2007 to consider and possible approve the revised texts

Entering into force 2010?

EU Regulation - Marine fuel directive 2005/33/EC

IN THE BALTIC SEA (2006) & NORTH SEA (2007)

- All ships of all flags to use <1.5% sulphur fuel (any grade)
- Member States to help ensure fuel availability (supplier register)

THROUGHOUT EU (2006)

- Regular passenger vessels to use <1.5% S in territorial seas

IN ALL EU PORTS (2010)

- **All ships at berth to use <0.1% S fuel. Exemptions for:**
  - Short-stay vessels (<2 hours in port)
  - Ships switching off all engines and using shore-side electricity

SCRUBBING AS AN ALTERNATIVE

- Exhaust gas cleaning technology (committee process to approve)

For more info on the EU Sulphur Direvtive

http://www.europa.eu.int/comm/environment/air/transport.htm#3

Future regulatory perspectives

- MEPC 53 set broad terms of reference for review of Annex VI, by 2007:
  - NOx, SOx, VOC, PM; examining available & developing techniques, including new & existing engines, alternative fuels, non-diesel power plant
- EU Directive 2005/33 contains review clause, for Commission to consider by 2008:
  - Lower sulphur limits / additional EU SECAs
  - Taking account of IMO progress & new cost-effectiveness analysis of passenger vessel clause

Other regional or national regulations

Shore-side electricity

- Shore side electricity eliminates local emissions – air & noise
- Plenty of good examples
  - Gothenburg: Stena
  - Zeebrugge: Cobelfret
  - Seattle/Juneau: Alaska cruise
  - Los Angeles: China Line terminal
- New EU study finds it most effective for large regular ships
- Now potentially cheaper than switch to low sulphur fuel, because of high oil prices. Electricity tax exemption would make it even more attractive.

Standardization of on-shore power supply

Proposed by Sweden and Germany in a submission to MEPC 54 (March 2006)

Supported by a number of delegates

Also widespread scepticism that this will only be another source of income for ports, that the safety of the ship could be jeopardized due to power cuts and that the shore electricity is not necessary produced by cleaner means than on board.

MEPC 54 instructed the Secretariat to liaise with other organizations and report back to MEPC 55 in October 2006

From the MEPC 54 report:

Standardization of on-shore power supply

4.5 The Committee considered documents MEPC 54/4/3 by Germany and Sweden and MEPC 54/4/10 by Friends of the Earth International regarding standardization of onshore power supply connections and the justification for this. The Committee agreed that standardized power supply connections could benefit the industry but that further studies were needed before any decision could be made. The Committee noted the information provided by the International Association of Ports and Harbors (IAPH) regarding ongoing standardization work: a meeting on the subject with the industry was deferred until after MEPC 54 so that IMO would be able to reach a conclusion and IAPH offered to co-operate with IMO on further work. The Committee also noted the view of the delegation from Venezuela to involve the IAPH, and in particular the Inter-American Commission of Ports, as the appropriate forums. The Committee further noted the ongoing work in the International Standardization Organization (ISO) related to onshore power supply. The Committee instructed the Secretariat to liaise with relevant international and intergovernmental organizations and report back to the Committee at the next session.

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Safe, secure and efficient shipping on clean oceans

Thank you for your attention!

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