International Convention for The Prevention of Pollution from Ships, 1973/78 (MARPOL)

Prof. Manuel Ventura

MSc in Marine Engineering and Naval Architecture

Historical Background

• In 1954, the United Kingdom organized a conference on oil pollution which resulted in the adoption of the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954.

• Following entry into force of the IMO Convention in 1958, the depository and Secretariat functions in relation to the Convention were transferred from the United Kingdom Government to IMO.

• In 1967, the tanker Torrey Canyon grounded in the English Channel and spilled her entire cargo of 120,000 tons of crude oil into the sea, resulting in the biggest oil pollution incident ever recorded up to that time.

• An international Conference in 1973 adopted the International Convention for the Prevention of Pollution from Ships
Determines

- Limits for spills of oil to the sea
- Necessity of segregated ballast tanks and the necessary conditions to their dimensioning.
- Existence, quantity and capacity of the slop tanks (tanques de decantação).
- Existence and specification of the oily water separation systems and the de monitoring of the oil content in the oily water outflow
- Existence of sludge tanks (tanques de resíduos oleosos)
- Location of the piping for water discharges
- Maximum limits of discharge of oil in the event of damage
- Standard damage dimensions, for damage stability assessment
- Maximum limits of the length and volume of the cargo tanks

M.Ventura  MARPOL  3

MARPOL

Application

- In general to all the ships
- In particular to tankers for the carriage of crude oil and oil products
- Chemical tankers

Does Not Apply to:

- Warship, naval auxiliary or other ship owned or operated by a State and used, for the time being, only on government non-commercial service.
Annex I - Regulations for the Prevention of Pollution by Oil

- Details the criteria of oil discharge and defines measures to control the pollution by oil and oily substances.
- Introduces the concept of "special areas" which are considered vulnerable to pollution by oil. The discharges of oil in those areas are completely prohibited, with minor and well-defined exceptions.

Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk

- Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk.
- Classifies the substances and provides detailed operational standards and procedures. About 250 substances were evaluated and listed.
- The discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with.
- In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land. More stringent restrictions applied to the Baltic and Black Sea areas.
Annex III - Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form

- Contains general requirements for the issuing of detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances.

Annex IV - Prevention of Pollution by Sewage from Ships

- Contains requirements to control pollution of the sea by sewage.

Annex V - Prevention of Pollution by Garbage from Ships

- Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of.
- The requirements are much stricter in a number of "special areas".
- The most important feature is the complete ban imposed on the dumping into the sea of all forms of plastic.
Layout of the Convention

Annex VI - Prevention of Air Pollution from Ships

- Set limits on sulphur oxide (SOx) and nitrogen oxide (NOx) emissions from ship exhausts and prohibit deliberate emissions of ozone depleting substances
- Specifies requirements for testing, inspection and certification of marine Diesel engines, to guarantee their compliance with the above limits.

 Definitions (1)

Harmful substance - means any substance which, if introduced into the sea, is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea, and includes any substance subject to control by the present Convention.

Discharge - in relation to harmful substances or effluents containing such substances, means any release howsoever caused from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying.

"Discharge" does not include:
- Dumping within the meaning of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972)
- Release of harmful substances directly arising from the exploration, exploitation and associated offshore processing of sea-bed mineral resources
- Release of harmful substances for purposes of legitimate scientific research into pollution abatement or control.
Definitions (2)

**Special Area** - means a sea area where for recognized technical reasons in relation to its oceanographic and ecological condition and to the particular character of its traffic, the adoption of special mandatory methods for the prevention of sea pollution by oil is required.

Definitions (3)

**Dedicated Clean Ballast Tanks (CBT)**
- Tank which since oil was last carried therein, has been so cleaned that any effluent discharged from a ship which is stationary into clean calm water would not produce visible traces of oil on the surface of the water or cause a sludge or emulsion to be deposited beneath the surface of the water.
- If the ballast is discharged through a monitor the oil content shall be ≤ 15 ppm.

**Protective Location (PL)**
- Dispositions about the location and dimensions of the segregated ballast tanks in relation to the cargo tanks.
- Mandatory in all the oil tankers with 20,000 t and product tankers with 30,000 t.
**Definitions (4)**

**Segregated Ballast Tank (SBT)**
- Tank which is completely separated from the cargo oil and oil fuel system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances
- Avoids the mixing of oil in the water that occurred when cargo tanks were used for ballast
- Mandatory in all the oil tankers with DW > 20,000 t and product tankers with DW > 30,000 t.

**Crude Oil Washing (COW)**
- Washing system for the cargo tanks by means of high pressure washing machines, using the cargo oil itself, heated.
- Mandatory in all the oil tankers with DW > 20,000 t.

---

**Definitions (5)**

**Slop Tank** - means a tank specifically designated for the collection of tank drains, tank washings and other oily mixtures.
Annex I - Regulations for the Prevention of Pollution by Oil

Segregated Ballast Tks, Dedicated Clean Ballast Tks and Oil Washing

Required for all the new ships:
- For the carriage of crude oil with DW > 20,000 t
- For the carriage of oil products with DW > 30,000 t
Segregated Ballast Tks, Dedicated Clean Ballast Tks, and Oil Washing

- The capacity of these tanks shall be such that the ship can operate in safety in the ballast conditions and satisfy the following criteria:
  - The molded draught amidships shall be
    \[ T_m \geq 2.0 + 0.02L \]
  - The trim aft, shall be
    \[ d \leq 0.015 \cdot L \]
  - The molded draught at PPAR shall guarantee the total immersion of the propeller

Requirements for the Crude Oil Washing (COW)

- Before the departure for a ballast voyage, after the complete discharge of the ship, a sufficient number of tanks should be washed with oil to avoid the ballasting of cargo tanks that were not washed with oil.
- In ships with SBT, about 25% of the tanks in every voyage, to control the sludge, although no tank needs to be washed for that purpose more than once in every 4 months.
- In oil tankers with insufficient capacity of SBT, the number of tanks washed with oil should be increased above that minimum in order to obtain a sufficient number of clean cargo tanks (as defined by the rules) to allow the reception of water ballast sufficient to attain the ballast draught required for the voyage.
Protective Location and Segregated Ballast Spaces

- The arrangement of segregated ballast tanks and other spaces not for oil shall be such that the following expression verifies:

\[ \sum PA_c + \sum PA_s \geq J \left[ L_T (B + 2D) \right] \]

where:

- \( PA_c \) = Area of the side shell \([\text{m}^2]\) for each segregated ballast tank, based on the projected dimensions
- \( PA_s \) = Area of the bottom \([\text{m}^2]\) for each segregated ballast tank
- \( L_T \) = Length \([\text{m}]\) of the cargo area
- \( B \) = Breadth, max. \([\text{m}]\)
- \( D \) = Depth, molded \([\text{m}]\)
- \( J \) = 0.45 \( p/\text{DW} = 20,000 \text{t} \)
  
  0.30 \( p/\text{DW} = 200,000 \text{t} \)

For intermediate values of \( \text{DW} \), \( J \) will be obtained by linear interpolation.

M.Ventura  MARPOL  19

Double Hull (1)

All the tankers with \( \text{DW} > 5,000 \text{t} \) shall satisfy the following requirements:

- The cargo zone shall be protected by ballast tanks or other spaces not containing cargo or fuels, according to the following:
  - Wing Tanks or Side Spaces
    - The cargo tanks shall be at a distance from the side shell molded line not less than the lesser of

\[ w = 0.5 + \frac{DW}{20,000} \quad \text{or} \quad w = 2.0 \quad [\text{m}] \]
Double Hull (2)

- Tanks or spaces in the double-bottom
  - The distance measured on the mold line from the bottom to the double-bottom shall not be less than the lesser of
    
    \[ h = \frac{B}{15} \quad \text{or} \quad h = 2.0 \quad [\text{m}] \]

- Bilge Zone
  - When the distances \( h \) e \( w \) are different, the distance \( w \) is used when it reaches values > 1.5h

Double Hull (3)

Total Capacity of the Ballast Tanks
- In crude-oil tankers with \( DW > 20,000 \) t or product with \( DW > 30,000 \) t, the total ballast capacity of the wing tanks, double-bottom, fore and aft peak tanks shall not be less than the required by the segregated ballast (Regulation 13).
- The wing tanks and double-bottom tanks shall distributed in the most uniform possible way along the cargo area.

Bilge Wells in Cargo Tanks
- The bilge wells can penetrate the double-bottom under the boundary defined by the line of height \( h \), iff the distance from the bottom of the well to the bottom of the ship is \( <= 0.5h \).
Double Hull (4)

Ballast and Cargo Piping

- Ballast piping and others such as venting and sounding shall not cross the cargo tanks.
- Cargo piping shall not cross through the ballast tanks.

Retention of Oil on Board

Slop Tanks

- Mandatory in oil tankers with GT > 150
- Capacity not less than:
  - 3% of the cargo capacity of the ship or,
  - 2% in ships with tank washing by water, if the volume of water contained in the slop tanks is sufficient for the cleaning and for driving the ejectors
  - 2% if the ship has SBT or CBT or a COW system installed, with the possibility of reducing to 1.5% if the volume of water contained in the slop tanks is sufficient for the washing and for driving the ejectors
  - 1% in combined ships where the oil is carried only in tanks with flat walls, with the possibility of reduction to 0.8% if the volume of water contained in the slop tanks is sufficient for the cleaning and for driving the ejectors
Discharge Monitoring and Control Systems and Oil Filtering Equipment

• All ships with $400 < GT < 10,000$ shall be equipped with:
  - Oil/Water Separator, 100 ppm

• All ships with $GT > 10,000$ shall be equipped with:
  - Oil/Water Separator, 100 ppm
  - Filtering equipment, 15 ppm

M.Ventura MARPOL

Sludge Tanks

• All ships with $GT > 400$ shall be equipped with:
  - Tank(s) with adequate capacity to receive the oil residues such as those resulting from depuration of fuel oils and lubricating oils and from leaks in machinery spaces.

• The capacity of the tanks shall be:
  - Ships that do not carry ballast in cargo tanks:

\[ V_t = K_1 C D \quad [m^3] \]

$K_1 = 0.01$

$C = \text{daily consumption of fuel oil} \; [t]$

$D = \text{max. time between ports where oils can be unloaded. Use 30 days if information is not available} \; [\text{days}].$

M.Ventura MARPOL
Protection of the Bottom of the Pump Room

- Oil tankers with DW ≥ 5,000 t shall have a double-bottom under the pump room area
- The double-bottom can be used as:
  - Void
  - Ballast tank
  - Fuel oil tank (if it does not violate other regulations, namely Reg. 17A)
- Ballast piping can be located in the double-bottom of the piping room if any damage in these pipes does not make the pumps inefficient
- Refer to IACS

Protection of the Fuel Tanks (1)

- Alteration from 2006
- Applies to all ships with aggregate fuel capacity ≥ 600 m³
- Intends to obtain for the fuel oil tanks the same degree of safety existing for the cargo tanks in tankers
- Does not apply to tanks with a capacity < 30 m³, unless the aggregated capacity is ≥ 600 m³
- The individual tanks shall not have capacity ≥ 2500 m³
Protection of the Fuel Tanks (2)

- Protection on the double-bottom
  - \( H > \text{Min} \left( \frac{B}{20}, 2.0 \text{ m} \right) \)
  - \( H_{\text{min}} = 0.76 \text{ m} \)

In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the oil fuel tank boundary line shall run parallel to the line of the midship flat bottom (IACS interpretation)

Protection of the Fuel Tanks (2)

- Protection at side shell (Ships with \( 600 \text{ m}^3 < \text{Vol} < 5,000 \text{ m}^3 \))
  - \( W = 0.4 + \frac{2.4C}{20000} \text{ m} \)
  - \( W_{\text{min}} = 1.00 \text{ m} \)
  - \( W_{\text{min}} = 0.76 \text{ m} \) (for tanks with individual capacity < 500 m³)

- Protection at side shell (Ships with > 5,000 m³)
  - \( W = \text{MIN} \left( 0.5 + \frac{C}{20,000}, 2.0 \right) \text{ m} \)
  - \( W_{\text{min}} = 1.00 \text{ m} \)

\(<w>\) is measured at any cross-section at right angles to the side shell (IACS interpretation)
Protection of the Fuel Tanks (3)

**Alternative Method**

- As an alternative to the requirements above the ship can be designed to comply to a value of the *accidental oil fuel outflow performance standard* defined in the Regulation.
- The design shall be evaluated based on the level of protection against pollution by oil in cases of collision or grounding, based on a *mean oil flow parameter*.
- This alternative method can result into tanks with only a partial or null double hull.

Protection of the Fuel Tanks (4)

**Piping**

- The pipes inside the line at \(<h>\) from the bottom or \(<w>\) from the side shell shall be equipped with valves inside or adjacent to the fuel tank.

**Suction Wells**

- May cross the boundary line defined by \(<h>\) and by \(<w>\), but shall be as small as possible and their bottom shall be at a distance \(\geq h/2\) from the outside of the hull.

Protection of the Fuel Tanks (5)

Fig. 1A 15,000DWT Tanker (Original)

Fig. 1A Panama Tanker (Original)

Fig. 1B 35,000DWT Tanker (Modified)

Fig. 1B Panama Tanker (Modified)

M. Ventura  MARPOL  33

Protection of the Fuel Tanks (6)

Fig. 1A Aframax Tanker (Original)

Fig. 1A Suezmax Tanker (Original)

Fig. 1B Aframax Tanker (Modified)

Fig. 1B Suezmax Tanker (Modified)

M. Ventura  MARPOL  34
Protection of the Fuel Tanks (7)

Fig. 5A VLCC 1 (Original)

Fig. 5B VLCC 1 (Modified)

Fig. 6A VLCC 2 (Original)

Fig. 6B VLCC 2 (Modified)

M. Ventura

MARPOL

35

Protection of the Fuel Tanks (8)

Fig. 7A VLCC 3 (Original)

Fig. 7B VLCC 3 (Modified)

Fig. 8A 30,000DWT Bulker Class (Original)

Fig. 8B 50,000DWT Bulk Carrier (Modified)

M. Ventura

MARPOL

36
Protection of the Fuel Tanks (13)

Fig. 16A 87,000 DWT Bulk Carrier (Original)

Fig. 17A 90,000 DWT Bulk Carrier (Original)

Fig. 16B 87,000 DWT Bulk Carrier (Modified)

Fig. 17B 90,000 DWT Bulk Carrier (Modified)

M. Ventura  MARPOL  41

Protection of the Fuel Tanks (14)

Fig. 18A Cape Size Bulk Carrier 1 (Original)

Fig. 18B Cape Size Bulk Carrier 2 (Original)

Fig. 19A Cape Size Bulk Carrier 1 (Modified)

Fig. 19B Cape Size Bulk Carrier 2 (Modified)

M. Ventura  MARPOL  42
Protection of the Fuel Tanks (15)

Fig. 20A  Cape Size Bulk Carrier 3 (Original)

Fig. 21A  Cape Size Bulk Carrier 4 (Original)

Fig. 20B  Cape Size Bulk Carrier 3 (Modified)

Fig. 21B  Cape Size Bulk Carrier 4 (Modified)

M. Ventura  MARPOL  43

Protection of the Fuel Tanks (16)

Fig. 22A  Cape Size Bulk Carrier 5 (Original)

Fig. 23A  3,000,000cf Wooden Chip Carrier 1 (Original)

Fig. 22B  Cape Size Bulk Carrier 5 (Modified)

Fig. 23B  3,000,000cf Wooden Chip Carrier 1 (Modified)

M. Ventura  MARPOL  44
Protection of the Fuel Tanks (23)

Protection of the Fuel Tanks (24)
Subdivision and Stability

- **Side Damage**
  
  \[ l = \text{MIN}\left(\frac{1}{3} L^2, 14.5 \text{ m}\right) \]
  
  \[ t = \text{MIN}\left(\frac{B}{2}, 11.5 \text{ m}\right) \]

  \[ v : \text{From the mold line of the bottom plate in the centre plane, upwards, without any limits} \]

- **Bottom Damage**

<table>
<thead>
<tr>
<th>Zona AR 0.3 L. AV</th>
<th>Resto do Navio</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ l = \text{MIN}\left(\frac{1}{3} L^2, 14.5 \text{ m}\right) ]</td>
<td>[ l = \text{MIN}\left(\frac{1}{3} L^2, 5 \text{ m}\right) ]</td>
</tr>
<tr>
<td>[ t = \text{MIN}\left(\frac{B}{2}, 10 \text{ m}\right) ]</td>
<td>[ t = \text{MIN}\left(\frac{B}{2}, 5 \text{ m}\right) ]</td>
</tr>
<tr>
<td>[ v = \text{MIN}\left(\frac{B}{15}, 6 \text{ m}\right) ]</td>
<td>[ v = \text{MIN}\left(\frac{B}{15}, 6 \text{ m}\right) ]</td>
</tr>
</tbody>
</table>

Hypothetical Oil Outflow

- **Side Damages**
  
  \[ O_c = \sum W_i + \sum K, C_i \]

- **Bottom Damages**
  
  \[ O_c = \frac{1}{3} \left( \sum Z, W_i + \sum Z, C_i \right) \]
Size Limits and Arrangement of the Cargo Tanks

- **Admissible outflow** \(\leq \text{MAX}(30,000 \text{ m}^3, 400 \sqrt{\text{DW}})\), but does not need to be > 40,000 m3.

- **Volume of the Side Tank** \(\leq 75\%\) of the admissible outflow

- **Volume of the Central Tank** \(\leq 50,000 \text{ m}^3\).

- **Length of the Cargo Tanks** - Not to be superior to the maximum of
  - 10 m and of
  - 0.10 L – ships without longitudinal bulkhead
  - 0.15 L – ships with longitudinal bulkhead
  - 0.20 L – wing tank of ships with 2 or more longitudinal bulkheads
  - 0.20 L – central tanks with \((b/B) \geq 1/5\)
  - \((0.50 b/B + 0.10) L\) – central tanks with \((b/B) < 1/5\) without centreline bulkhead
  - \((0.25 b/B + 0.15) L\) – central tanks with \((b/B) < 1/5\) with centreline bulkhead

Subdivision and Stability

**Damaged Stability Criteria**

- The final waterline shall be under every opening that may cause progressive flooding.

- The heeling angle due to the asymmetric flooding shall not exceed 25°, or 30° if the edge of the deck is not submerged.

- The curve of stability shall extend by 20° beyond the equilibrium position and shall have a stability lever of at least 0.1 m in that range of the 20°.

- The area under the curve \(\geq 0.0175 \text{ m.rad}\).