Tanker Safety - Regulatory Change [1]

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Abstract: *There are many regulatory changes being imposed on tanker operators of new and existing ships. This paper provides a brief on the main changes and their practical impact on design and operation i.e. the significant recent and upcoming revisions to IMO MARPOL Annexes I, II and VI, SOLAS and other regulations and the IACS Common Structural Rules.*

1 - Introduction

Regulatory changes are often driven by the continued desire to provide for higher levels of safety to protect life, property and the environment together with the natural progression of technical knowledge. As a result of this objective and adjustment, significant amendments to regulations and classification services have occurred within the past seventeen years including MARPOL and SOLAS upgrades, OPA 90 and the Common Structural Rules for Oil Tankers and Bulk Carriers. Additionally a large number of other significant regulatory requirements changing the way the marine business operates have also been developed and implemented, for example the ISM and ISPS Codes.

The fact of the matter is that the tanker industry has shown significant improvement in its pollution record. When measured in terms of the number of pollution incidents Figure 1 shows a clear decline (bars) despite a growing number of tonne miles delivered (line).

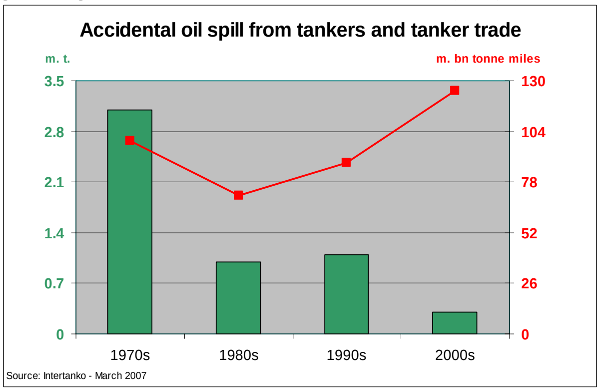

Figure 1 - Tanker Industry pollution performance

Also when considering the total constructive losses and casualties (since both can produce a pollution incident) for different tanker types compared with other cargo ships one can clearly see that tankers have a better than average performance. The specific data is provided in Table 1 below. This table shows an index which represents the average annual loss rate relative to the number of ships at risk. The data presented is from the period 1991 to 2006 for cargo ships greater than 1,000 t dwt. It can be seen that the safety record for crude oil tankers is superior to other ship types on losses. These results have improved significantly compared to the period 1980 to 1991 (Ref.1). Chemical ships are further down the list and this is surprising since in the situation was reversed for these two ship types over the earlier period. In terms of ships being involved in casualties crude oil tankers are again in second place.

Ship Type	Loss	Casualty
LNG Carrier	0	6.79
Oil Carriers	0.233	18.17
Container Ships	0.883	36.91
Product Tankers	0.975	27.69
Bulk Carriers	1.094	34.96
LPG Carriers	1.378	19.08
Chemical Carriers	2.055	26.63
Refrigerated Cargo Ships	2.209	26.69
Ro-Ro's	2.756	42.33
OBOs	2.984	50.58
General Cargo Ships	5.868	41.96
Average all cargo ships	3.053	33.79

Table 1 - Average annual loss & casualty rate per 1000 ships at risk. ***(Source: ABS analysis of Seaway data)***

It can be seen from Figure 2 that the most common type of casualty for a tanker in 2006 was collision closely followed by machinery failure then being wrecked or stranded. This data also provides evidence that machinery reliability has improved since the early 1990's when machinery failures accounted for the largest proportion of casualties. This population is the same as for Table 1.

[1] International Symposium on Maritime Safety, Security and Environmental Protection, 20-21 September 2007, Athens, Greece.

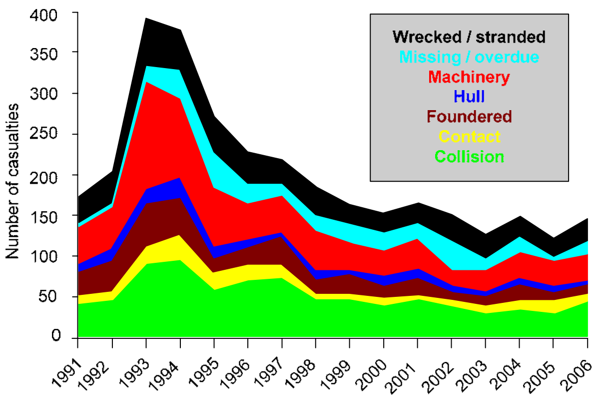

Figure 2 - Types of casualty for crude oil tankers
(Source: ABS analysis of Seaway data)

The average age at the casualty incident for all ships in the 16 year sample is about 17 years. Container ships and oil tankers are likely to be involved in a casualty incident at a younger age than all other ship types most probably because both these ship types have a lower average age for their operating fleets. This population is the same as for Table 2.

Ship type	Age
Container Ships	10.8
Oil Carriers	13.8
LNG Carriers	14.5
Product Tankers	15.3
Chemical Carriers	15.6
Refrigerated Cargo Ships	15.7
LPG Carriers	15.8
OBO's	16.6
Bulk Carriers	16.9
Ro-Ro's	17.8
General Cargo Ships	18.1
Average for population	16.78

Table 2 - Average age at casualty
Source: ABS analysis of Seaway data

By way of illustrating the significant effect of legislation, few requirements can be compared with the effect of OPA 90 and MARPOL 13 F/G/H. Both of these statutory instruments, developed in response to major casualties adversely impacting on the local environment, initiated major fleet renewal programs by the worlds' crude oil tanker owners. As a result the average age of the crude oil tanker fleet over 60,000 t deadweight over the past decade has decreased from 12.5 years to 9.4 years at the end of 2006.

The current existing fleet of crude oil tankers greater than 60 k t dwt consist of 1655 ships totaling approximately 277 m t dwt. Although the current order book for oil tankers greater than 60 k t dwt. is impressive at 485 ships or 90 m t dwt. – see Table 3 - there are still a substantial number of Category 2 and 3 single hulls to replace before the earlier of their phase out dates or 2015 – approximately 80m t dwt. Significantly, the rate of scrapping has slowed since 2001 – see Figure 3. A small number of the ships included in the order book are for replacement tonnage.

Ship type	Existing fleet	No. on order	% of fleet
LNG	216	148	68.50%
LPG	870	194	22.30%
Chemical	2918	846	29.00%
Crude Oil (>60k dwt)	1655	485	29.30%
VLCC	*502*	*165*	*32.90%*
Suezmax	*355*	*109*	*30.70%*
Aframax	*629*	*186*	*29.60%*
Panamax	*169*	*25*	*14.80%*
Oil Products	3716	561	15.10%
RoRo	1696	613	36.10%
GC	11586	742	6.40%
OBO	115	0	0.00%
Bulk carriers	6710	926	13.80%
Reefer	1034	14	1.40%
Other tankers	212	8	3.80%

Table 3 - Existing fleet and order book (no. of ships)
Source: LR Fairplay – Dec. 2006

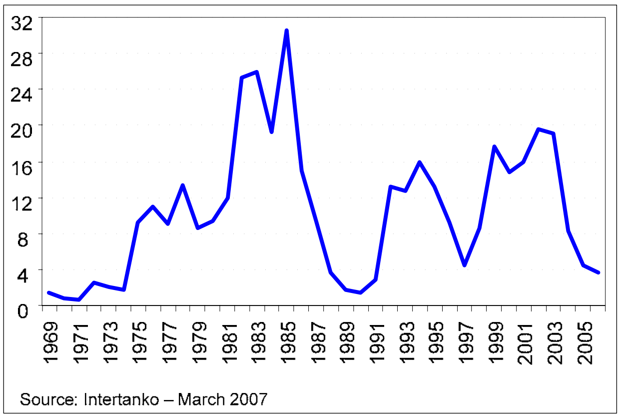

Figure 3 - Rate of scrapping (m. t. dwt)

This paper aims to provide an overview of the major current legislative changes for their effects on both existing and new tanker tonnage.

2 - MARPOL Annex I

2.1 Oil discharges from Engine Room

Regrettably there have been numerous incidents recorded where improper overboard discharges from engine rooms have caused pollution, resulting in large fines and other criminal sanctions. The operational problems affecting waste oil management in machinery spaces of ships are considered serious and have been discussed at IMO. These problems are complex and have necessitated a review of the requirements to establish a more achievable criteria for the oil pollution equipment, in particular oily water separators focused on addressing these problems from a more realistic and practical perspective. All contracting governments especially port states have been

urged by IMO to fulfill their obligation to provide adequate reception facilities.
The text of MARPOL 73/78 Annex I/Ch. 3 Regs. 12 & 14 is clear on the treatment of engine room oily waste – retention on board for discharge to reception facilities or discharge to the sea where oil content does not exceed 15 parts per million. MARPOL Annex I/Ch. 6 Reg. 38 covers discharge to reception facilities on shore.

2.1.1 MEPC 55

In October 2006 at the 55th session of MEPC the delegations considered this issue and there were a number of papers (Ref. 3-7) submitted all noting the complexity of the challenges related to the oil discharges from engine rooms. Papers were from both governments and non-governmental organizations (NGOs). The paper from Denmark (Ref. 3) provided the basis for discussion at MEPC 55 and included recommendations for:

- **a.** Definition of oil residue (sludge) and bilge water holding tanks
- **b.** Developing unified interpretations on how letter codes (A to H) in the Oil Record Book (ORB) are to be used
- **c.** Amending the International Oil Pollution Prevention (IOPP) Certificate Form A (ships other than oil tankers) and B (oil tankers)
- **d.** Developing supplementary guidelines for approval of bilge and sludge handling systems
- **e.** Update the revised guidelines for systems for handling oily wastes in machinery spaces of ships. MEPC.1/Circ.511

Support for a number of these recommendations led to the Design and Equipment (DE) sub-committee being tasked to review MEPC.1/Circ.511 and relevant MARPOL Annex I and Annex IV requirements with a target completion date of 2008. A correspondence group under the chairmanship of Denmark was established at DE 50 to progress work on these issues inter-sessionally.

The present guidelines for oil discharge equipment are under review by the IMO sub-committee on Design and Equipment and are to be discussed at the next session of the sub-committee in February 2008. At this meeting, a working group may be established to continue the efforts of the correspondence group. One of the objectives of the next session is to develop a draft MEPC Circular on the Harmonized Implementation of the Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of ships during the Type Approval process. The intent of this circular is to provide guidance towards more realistic on board operating conditions being taken in to account during the Type Approval process as the current text of MEPC 107(49) is in some cases vague and can lead to different interpretations being applied.

2.1.2 MEPC.1/Circ. 511

As mentioned above the correspondence group established at DE 50 has also been tasked with updating the revised guidelines contained in MEPC.1 Circular 511. This circular revised the guidance provided in MEPC/Circ. 235 and introduces the concept of an Integrated Bilge Water Treatment System (IBTS) to minimize the amount of oily water generated in the machinery space by treating the leaked water and oil separately.

The IBTS recommended by MEPC.1/Circ.511 is to aid in the compliance with the revisions to MARPOL Annex I taking into account the amount and treatment of oily bilge water that exist today. Note that the revisions to MARPOL Annex I did not change the oily bilge water requirements. Thus clean drains would be collected separately and ideally can be discharged directly without going through the oily water separator and oil content monitor. It also introduces a need for an additional tank for the purposes of a "clean drain tank". Thus there are tanks for clean drains , oil bilge water and oil residue (sludge). The sludge is recommended to be incinerated.

2.1.3 Non Governmental Organizations (NGO's)

Several submissions were made from NGOs including a paper from BIMCO (Ref. 4) providing specific comments to improve the present situation for consideration by IMO of:

- **a.** Oily Water Separator test to use fluids that represent those expected in the engine room. This is so that typical detergents, solvents, soot, particles, lubricating oil and hydraulic oil are included. There will be a need to continue evaluation as the fluids present will change with further development.
- **b.** Duration of the tests to be extended to 8 to 12 hours
- **c.** Limit use of filters for achieving a final target of 15 ppm from say 50 ppm.
- **d.** Increase height of holding tank. Modifying the configuration of the holding tank so settling occurs to improve separation.

INTERTANKO and INTERCARGO have expressed concerns relating to redesign of the system components of the IBTS.

Final guidance will not be available until 2009. Note that discharges are permitted within the allowable ppm concentration. The actual configuration of the tanks, especially the bilge primary tank and the oily water separator equipment with the oil content monitor must still be suitable to achieve the concentration levels.

2.2 Protective location for fuel oil tanks and associated piping

2.2.1 General

MEPC on 24 March 2006 has adopted MARPOL Annex I/Reg. 12A (Ref. 8). This regulation is applicable to all new[2] ships having an aggregate fuel oil capacity of 600 m^3 and greater to provide adequate protection against oil pollution in the event of grounding or a collision. Each bunker tank (which excludes tanks that do not normally carry fuel oil such as overflow tanks) fitted in such ships and having a capacity (98% of the tank's gross volume) greater than $30m^3$ is to be protectively located.
The revised MARPOL Annex I/12A limits the size of fuel oil tanks to not more than 2500 m^3 and requires fuel oil piping serving the fuel oil tanks to be located above the double bottom *unless* fitted with remotely operated (fail safe) isolation valves at the tank's penetration. Suction wells and valves shall not extend below h/2 above the shell plating. The term h is defined in the next section. Air pipes and overflows are not considered part of the fuel oil piping. There are two options to determine the extent of protection for fuel oil tanks, deterministic and probabilistic.
Other tanks such as overflow tanks not carrying fuel in normal operation would not be included in this requirement.
To help owners demonstrate compliance with these requirements, ABS has developed two notations POT and CPP.

2.2.2 Deterministic approach

The requirements for tank widths and height are determined from formulae. For fuel oil tanks (>30 m^3) on ships with aggregate capacity greater than 600 m^3 then:

- Minimum double bottom height, h, is the lesser of B/20 or 2m (min 0.76m);
- Minimum wing tank width, w, (for an aggregate capacity < 5,000 $m^{3)}$ is:
  = 0.4 + 2.4**C**/20,000 m
  (min. = 1.0m, however
  min. = 0.76m for individual tanks < $500m^3$);
- Minimum wing tank width, w, (for an aggregate capacity ≥ 5000 $m^{3)}$ is:
  = 0.5 + **C**/20,000 or 2m, whichever is less
  (min. = 1.0m);

where **C** is the total fuel oil capacity at 98% filling (including all small fuel tanks).
Suction wells in oil fuel tanks may protrude into the double bottom up to 50% of its depth.

[2] A new ship A new ship is defined as:

- A newbuilding contracted on/after 1 August 2007;
- keel laying date on/after 1 Feb 2008 (where there is no contract); or
- delivery on/after 1 August 2010 (regardless of the contract or keel laying date)
- a ship which has undergone a major conversion with the same dates as above.

2.2.3 Probabilistic approach

This is an alternative to the deterministic method and considers the location and size of bunker tanks and the probability of breaching the bunker tanks in the event of collision or grounding. Full background details on this can be found in Ref. 9. A quick summary of the approach is as follows:
a. Probability density functions have been determined for the likelihood of damage being encountered at different points in the length of the ship for both side and bottom damage and these are the same as adopted in Annex I/23 for cargo outflow calculations.
b. An assessment is then made of the expected oil outflow from each damaged tank or group of tanks including tidal effects and accounting for any retained oil. The oil outflow is estimated based on simple pressure balance principles.
c. The mean oil outflow is then calculated as the cumulative sum of the product of the probability of damage occurring to an individual tank or group of tanks and the expected oil outflow that could result from each.
d. The calculated mean oil outflow, O_M, is then compared with the criterion (Ref. MARPOL Annex I/12A.11) indicating either pass or fail.

$O_M < 0.0157 - 1.14xE^{-6}C$ if $600m^3 < \mathbf{C} < 5{,}000m^3$
$O_M < 0.010$ if $\mathbf{C} > 5{,}000m^3$

where **C** is the total FO capacity at 98% filling (including all small fuel tanks).

2.2.4 Cargo capacity

As can be imagined there are different solutions being considered for each ship type to minimize the impact on cargo capacity of protectively locating the fuel oil tanks. To date all solutions which have been presented are focusing on the utilization of other spaces located within the hull. For example on containerships designers are evaluating the use of cofferdams between holds and for bulk carriers options include the use of the upper wing tanks for bunker tanks. Many designers are also exploring the engine room fuel oil tanks where there is space. For most designs it is likely there will be some cargo space loss in order to store the requisite volume of bunkers away from the shell and in protected locations.

Shipbuilders have arrived at a number of solutions for oil and chemical carriers and examples of some of these can be seen in Figure 4. One of the critical issues will be access for inspection and survey of the side shell spaces since the minimum allowable is 0.76m or 1m - see 2.2.2 above. This is challenging for inspection purposes. In general, given the capacity limited nature of oil and chemical tankers there is a loss of carrying capacity in the region of 1500-5000 m^3 (bunker capacity) depending upon ship type and whether space can be found outside the cargo area in the ship configuration.

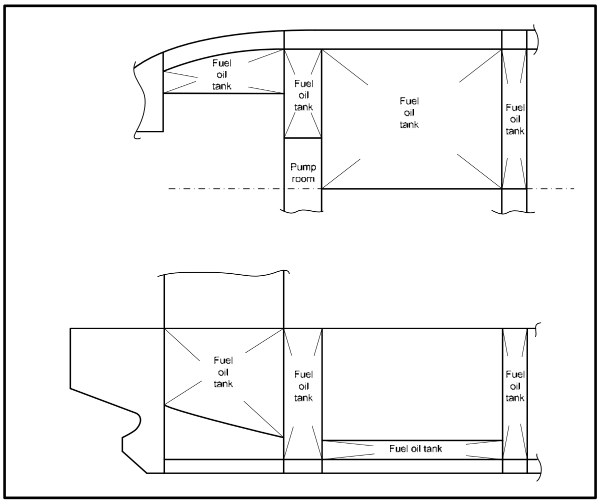

Figure 4– Examples of possible fuel oil tank locations for oil and chemical carriers

2.3 Accidental oil outflow performance

MEPC has also adopted a revised MARPOL Annex I/23 and 24 (Ref. 10). Once again this regulation is applicable to all new[3] oil tankers to provide adequate protection against oil pollution in the event of grounding or collision. The previous Revised Interim Guidelines (Ref. 11) are now superseded. The method applicable is in MARPOL Annex I/23 and the extent of the damage to be applied is defined in MARPOL Annex I/24.
The same method is used for the cargo tanks as is used for the fuel oil tanks (described here in section 2.2.3) except with different criteria for mean oil outflow and modified formulae for the height of oil in the cargo tanks.
The criterion (Ref. 10) for the oil outflow from the cargo tanks is ship size dependant. For ships greater than 5,000 t dwt the mean oil outflow criteria are:

$O_M < 0.015$ if $\mathbf{C} < 200{,}000\text{m}^3$

$O_M < 0.012+(0.003/200{,}000).(400{,}000-\mathbf{C})$ if $200{,}000\text{m}^3 < C < 400{,}000\text{m}^3$

$O_M < 0.012$ if $\mathbf{C} > 400{,}000\text{m}^{3,}$

where **C** is the total cargo capacity at 98% filling.
For ships less than 5,000 t dwt. the length of the cargo tanks are controlled in order to minimise oil pollution in the event of grounding or collision.
The method is essentially a simplification of the former revised interim guidelines. This approach works well for most tank configurations. The method is also applicable to combination ore/oil carriers.
Piping located in cargo tanks less than $0.3B_{mld}$ from the ships side or less than $0.3D_{mld}$ from the ships bottom are to have closing devices at the point of opening into each cargo tank.

2.4 Cargo pump room double bottoms

This is applicable to all oil tankers of 5,000 t dwt and above as required by MARPOL Annex I/22 (Ref. 10) constructed on or after 1 January 2007. A double bottom is required and the criterion for depth is the same as for the cargo area. This is to allow for cargo offloading in the event of bottom damage in way of the pump room. If the flooding of the cargo pump room does not render the cargo pumps ineffective then this requirement can be waived. Ships with gondola sterns are exempted from this requirement where the pump room would be above the minimum double bottom height requirement – see Figure 5.

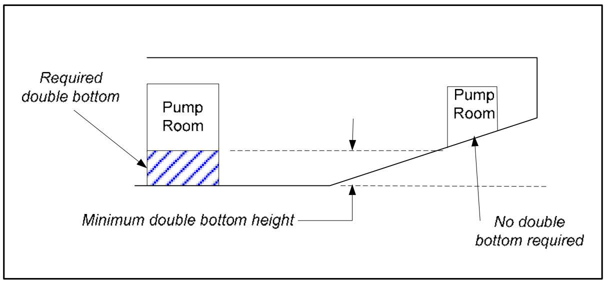

Figure 5– double bottom height in cargo pump room

2.5 Shore side computing support

MARPOL Annex I/37.4 (Ref.10) - oil tankers are required to have prompt access to shore-side computing facilities for the calculation of damage stability and residual structural strength (effective 1 January 2007).

Associated with the issuance and endorsement of the IOPP Certificate, the Recognized Organization must verify that the above requirement has been met as compliance with this regulation is to be recorded to the Supplement to the IOPP Certificate. At MEPC 55 it was agreed that this verification should consist of the following:

1. a contract linking the ship with a shore based firm and a copy is kept on board
2. the acquisition of a statement from the shore based firm indicating that it is capable of providing computer calculation capabilities, and
3. verification that the master has means to access the shore based firm at any time

3. MARPOL Annex II and the IBC Code

3.1 General

Liquid chemical cargoes (substances) have been categorized according to the new Global Harmonized System. This system has resulted in a number of substances that prior to its implementation date of 1 January 2007 were being shipped as Noxious Liquid Substances (NLS) or oil-like substances are now required to be transported in a chemical tanker that complies with the revisions to the IBC Code and MARPOL Annex II (Refs:12 & 13). Annex I tankers previously carrying vegetable oil cargoes

[3] A new ship is defined as:
- A newbuilding contracted on/after 1 January 2007;
- keel laying date on/after 1 July 2007 (where there is no contract); or
- delivery on/after 1 January 2010 (regardless of the contract or keel laying date)
- a ship which has undergone a major conversion with the same dates as above.

also need to be certified as chemical tankers under the IBC Code. In some cases substantial modifications may be required for an existing vessel to meet the new pollution and safety requirements. There is a significant new construction order book at present for chemical ships. Some owners have considered upgrading ships previously carrying NLS cargoes to Type 3 chemical ships and other owners may wish to upgrade from Type 3 to a Type 2 ship (see Table 5 for ship type definitions). Both are potentially complex upgrades with many practical issues involved. A detailed assessment is required for each ship. The main features that should be reviewed are summarized in Table 4 and supported below by relevant detailed discussion.

3.2 NLS Tanker to Chemical Ship

3.2.1 Depth of double bottom

If the existing ship has a double bottom height that complies with the chemical ship requirements this may be a deciding factor if an IBC Type 1 or 2 ship is required. There is no double-bottom height restriction for a Type 3 ship. For a Type 1 or 2 IBC ship the double bottom depth requirement is different than for MARPOL. The critical point is for ships greater than 30m B_m. Looking at two cases demonstrates the issue:

1. If B (existing oil tanker) = 29m double bottom depth is likely to be 1.93 m for MARPOL compliance. In this case this also complies with IBC requirements since B/15 gives the same requirement.
2. If B (existing oil tanker) = 31m double bottom depth is likely to be 2m for MARPOL. This does not comply with IBC which would require 2.06m (B/15) as minimum for IBC.

Hence this may be a deciding factor in a conversion decision since increasing double bottom height is likely to be prohibitively expensive. However if the ship is going to carry vegetable oils there may be dispensation in the form of a relaxation by the Flag State. An administration may permit some vegetable oils (as indicated with "2(k)' in column "e" of IBC Code Chapter 17) to be carried in Type 3 chemical tankers, except that the entire cargo block length must then be protected by double hulls that comply with the following dimensions; 760mm wing tank width, and B/15 or 2 m double bottom height at centerline, whichever is lesser but not less than 1 m.

3.2.2 Side width

MARPOL requires a 2 m width and IBC Code 760mm so there is normally no conflict.

3.2.3 Damage

The applicable standard is length dependant and is more severe for the same size of chemical ship. E.g. for a typical 50 k t dwt oil tanker or Type 3 IBC ship with L = 180 m damage shall be anywhere in the length excluding the engine room. For a Type 2 ship, engine room damage is to be included. This is a significantly greater requirement and margin line submersion may immediately be the limiting factor in compliance with the Type 2 standard. This may require further subdivision of the cargo tank forward of the engine room as well as appropriate arrangement of fuel tanks in the engine room. The MARPOL revision to keep fuel oil separated from the shell must be considered when selecting the final arrangement of the engine room and the cargo tank forward of the engine room.

3.2.4 Cargo capacity limits

There is no restriction for the amount of cargo that can be carried in tanks arranged in oil tankers and IBC Type 3 ships. IBC Type 2 ships have a cargo quantity limit per tank of 3,000 cubic meters. Larger capacity tanks can be slack loaded but the cargo capacity of the ship may be limited, the intact and damage stability capability will need to be re-checked considering free–surface effects and the tank boundaries will have to be checked for sloshing loads. Tank size may be a deciding criterion in selecting ships appropriate for upgrading. A recent decision at MEPC 56 confirmed that Type 2 ships may not carry any cargo (veg. oils or other) in parcels greater than $3000m^3$ as defined by MARPOL Annex II. It was also recognized that downgrading the certification from Type 2 to Type 3 for the purpose of carrying more than $3000m^3$ in a tank was not a violation of MARPOL Annex II.

3.2.5 Tank stripping limits

An oil tanker has no prescribed requirement for tank stripping and hence this is driven primarily by commercial concerns. A chemical ship requires a timed test to establish tank residue at or below certain limits and the acceptable residue is dependant upon the MARPOL pollution category (X, Y or Z) for the product. See Table 6.

Generally a tanker will have a pump room arrangement whereas a chemical ship will have a pump and associated piping for each tank to maximize parcel carrying capability. The presence of a pump room can lead to a lack of commercial flexibility but this also makes it more difficult to comply with the stripping requirements of the IBC Code since the residue covers the tank(s), the pump and the piping up to the manifold hence a pump room arrangement may require additional stripping capacity to be retrofitted and/or revised pumping arrangements to be considered.

3.2.6 Overboard discharge

For oil tankers this may be above the waterline whereas for chemical ships this must be below the waterline. However, it is common for oil tankers to be fitted with underwater discharge systems so this may, or may not, lead to a retrofit requirement. The underwater discharge is usually located such that discharge remains within the boundary layer of the hull, dissipates into the propeller race and thence to the ships wake – hence discharge flow rate is also an important variable to be controlled.

Feature/criteria	Oil tanker – MARPOL	Chemical – IBC Code
Double bottom depth	Lesser of B/15 or 2 m	Lesser of B/15 or 6 m type 1 & 2
Side width	2 m	Type 3 single side, type 2 minimum of 760 mm
Damage	Under 225 m no engine room damage	Type 3 no engine room damage, type 2 engine room damage
Number of tanks	Generally 10	Generally 10 or more
Number of segregations	Generally 1 to 4	Generally each tank
Pump arrangements *	Pump Room	In tank pumps / pump room
Stripping	Commercial concern	Based on pollution criteria X,Y,Z or other substance
Cargo loading	No restrictions other than product commercial concerns	Compatibility with other cargoes needs to be verified
Overboard discharge	Above waterline	Below waterline
Fire fighting medium	Foam	Foam, water-spray or dry chemical
Fire fighting capacity	1	3 to 4 times greater
Vents	Height from Load line requirements = 900 mm and from SOLAS II-2 = 2m	Height 6 m or 3 m with high velocity
Environmental control	Inert gas system	Inert gas, padding or drying
Gauging	Closed gauging for ships with IGS	Closed, restricted or open
High and high-high alarms	Visual and audible	Visual and audible
Personnel protection	Per SOLAS	Cargo dependent (portable toxicity and flammability metering) and eye wash stations
Materials of construction	Commercial concern	Compatibility with cargoes to be evaluated

Table 4 – comparison of MARPOL and IBC requirements

IMO Type	Side damage	Bottom damage	Damage standard	Parcel size maximum
Type 1	B/5 or 11.5 m. whichever is less	B/15 or 6 m at CL. whichever is less but not less than 760mm	Damage anywhere in length	1250 cu. M.
Type 2	At least 760 mm	B/15 or 6 m at CL. whichever is less but not less than 760mm	Length >150 m. damage anywhere in length	3000 cu. M.
			Length <150 m. damage anywhere in length except ER bulkheads	
Type 3	**a.**	**a.**	Length >225 m. damage anywhere in length	No limit
			Length >125 m but <225 m. damage anywhere in length except ER bulkheads	
			Length <125 m. damage anywhere in length except ER bulkheads and machinery space	

Table 5– IBC ship type definition

Note a: An administration may permit some vegetable oils (as indicated with "2(k)' in column "e" of IBC Code Chapter 17) to be carried in Type 3 chemical tankers, except that the entire cargo block length must then be protected by double hulls that comply with the following dimensions; 760mm wing tank width, and B/15 or 2 m double bottom height at centerline, whichever is lesser but not less than 1 m.

3.2.7 Major conversion

The question has arisen of whether the change from an oil tanker to a chemical tanker should be construed as a major conversion under MARPOL. According to a strict reading of MARPOL Annex I/Reg. 1(9) this is a major conversion. Further, MARPOL Annex II/Reg. 14.1 specifies that a ship converted to a chemical tanker, irrespective of the date of construction, is to be treated as a chemical tanker constructed on the date on which such conversion commenced – it therefore must meet new ship requirements under the IBC Code.

3.3 Chemical ship Type 3 to ship Type 2

Provided the Type 3 ship is double hulled then the upgrade applicable is limited to consideration of cargo quantity limits and complying with the more onerous damage stability requirements. Of course there are additional requirements which are often associated with the NLS required to be carried in a Type 2 ship.

3.4 Materials of construction

One of the revisions to the IBC Code that may have not been so apparent is with respect to materials of construction, i.e. all the materials that come into contact with the cargo from the tank construction material, the coatings in the tank to the piping (packing in the piping flanges), pumps, valves and valve seat, etc..
Previously this was specified for each product and hence each government signatory to the IBC Code agreed on to this specification. The new IBC Code contains no such product and material compatibility references. A new requirement has been added to the Code such that the shipbuilder must provide to the shipowner a list all materials in the cargo handling systems for each ship. Effectively this serves to reinforce the shipowner and shipbuilder responsibility for the compatibility of the materials of construction with the cargoes to be carried.
The cargo list for the previous IBC Code included the material specification. Now the cargo list is not the list of cargoes that may be carried as it is the responsibility of the shipowner to be sure the materials of construction and coating for the piping and tank system are compatible with the intended cargoes.
Coating and cargo compatibility information is usually specified by the coating manufacturer including relevant information on cargo residence time, exposure conditions and subsequent cargoes. This complex subject is the responsibility of the ship Masters.

Requirement	**Previous MARPOL Annex II**				**Current MARPOL Annex II (1/1/2007)**			
Pollution Category	**A** Major Hazard	**B** Hazard	**C** Minor Hazard	**D** Recognizable Hazard	**X** Major Hazard	**Y** Hazard	**Z** Minor Hazard	
Maximum Residue After Stripping					**Ship Details**			
					IBC/BCH			Other
X [1] < 1/7/86 (BCH Ships)	Not Applicable	300 +50* liters[#]	900 +50* liters[#]	No minimum	300 +50* liters[#]	300 +50* liters[#]	900 +50* liters[#]	If "Z" and in IBC Ch.18, empty to maximum extent. If "OS" and in IBC Ch.18, not applicable
1/7/86 ≤ **X** [1] < 1/1/2007 (IBC Ships)		100 +50* liters[#]	300 +50* liters[#]	No minimum	100 +50* liters[#]	100 +50* liters[#]	300 +50* liters[#]	
X [1] ≥ 1/1/2007 (IBC Ships)	Not Applicable				75 liters[#]			
** performance test tolerance*					*[#] performance test required*			

Table 6 - IBC Code stripping and discharge requirements

Process	Pollutant	Effect
Health	$PM_{2.5}$, NO_X, VOCs	Fine Particles and Ozone produce a range of problems from minor respiratory effects to premature death and cardio-vascular effects. There is no known threshold for effects
Acid Rain	SO_2, NO_X, NH_3	affects freshwaters and terrestrial ecosystems leading to a loss of flora & fauna, reduced forest growth and leaching of toxic metals into soil solution.
Eutrophication	NO_X, NH_3	excess nutrient nitrogen causes species composition change, a loss of biodiversity and increases susceptibility to other stresses such as drought.
Ozone	NO_X, VOCs	damages trees and plants including agricultural crops; damages buildings/materials

Table 7- Health / environmental effects of air pollution. ***Source: Intertanko – March 2007***

4. MARPOL Annex VI

4.1 General

Current EU policies for land-based pollution sources are working towards delivering significant reductions in the emissions of the most important pollutants. Data collected by the EU point out that significant health and environmental problems will persist unless these airborne pollutants are reduced. The overall contribution to emissions of NOx and SOx from ships on a percentage basis will probably increase relatively due to the fact that land-based controls are further advanced than marine controls. Hence emissions from EU seas are predicted to be larger than those from EU land-based sources by 2020. Recent estimates from the scientific community in a study commissioned by the US Environmental Protection Agency suggest that ocean going vessels represent approximately 18-30% of the world's NOx pollution and 9% of global SOx emissions. The same study concludes that the current marine sulfur cap is about 3,000 times higher than commonly used land-based limits.
MARPOL Annex VI entered into force on 19 May 2005. This sets controls on NOx and SOx emissions. IMO is in the process of drafting a major revision to the convention due to the actions of various local administrations implementing unilateral regulations to control NOx and SOx emissions that are more restrictive than the present Annex VI. These local regulations also aim to control other pollutants including Particulate Matter, CO2, CO and hydro-carbons since each has undesirable health and environmental effects – see Table 7

Table 8 below summarizes the current Sulfur Emission Control Area (SECA) initiatives in place. Other SECA's under discussion include Singapore, Korea, Tokyo Bay (Japan), Mediterranean, Black Sea, Canada, Mexico and USA (various states). There is discussion at IMO of establishing NOx emission control areas (NECA's) as a further method of pollution control.

For tanker owners the most pressing issue is the NOx and SOx emissions from diesel engines (except those exclusively used for emergency service) in the Annex VI convention.

Area	Ship type	% SOx Max & ISO 8217 DM Grade	Effective	Regulation
Worldwide	All	4.50%	19 May 2005	IMO
All EU Ports	All	0.2% MGO (DMA;DMX) 1.5% MDO (DMB;DMC)	11 Aug 2006	EU
Baltic Sea	All	1.50%	19 May 2006	IMO EU
EU Waters	Passenger Ships	1.50%	11 Aug 2006	EU
From 24 Miles offshore California	All Aux. Engs. & Diesel/Elect. ME on Ships	0.5% MGO(DMA) or MDO(DMB)	1 Jan 2007	CARB
N. Sea & English Channel	All	1.50%	11 Aug 2007	EU
N. Sea & English Channel	All	1.50%	22 Nov 2007	IMO
All EU Ports	All	0.10%	1 Jan 2010	EU
All EU Inland Waters/ Rivers	EU Inland Waterway Vessels only	0.10%	1 Jan 2010	EU
Greece Ports	16 Designated Greek Ferries	0.10%	1 Jan 2010	EU
From 24 Miles offshore California	All Aux.& Diesel/Elect. ME on Ships	0.1% MGO(DMA)	1 Jan 2010	CARB

Table 8 - Current SOx Regulatory Regimes
Source: ABS/Intertanko – March 2007

4.2 NOx emissions from diesel engines

Nitrogen and oxygen combining at high temperatures during the combustion stroke cycle form NOx emissions from diesel engines. The current maximum NOx limits set by MARPOL Annex VI Reg. 13 are 17 g/kW h for engines with rpm less than 130 downward to 9.8 g/kW h for engines with rpm 2,000 and over. Engine manufacturers have used various methods to reduce NOx emissions to meet current Annex VI limits including adjusting valve timing, delaying injection, utilizing common rail fuel injection systems, installing modified low sac volume injectors, installing a turbo charger after cooling and other methods to reduce NOx generation by maximizing combustion efficiency. For further detail on engine design aspects see Ref. 14. To meet the more stringent NOx limits set by local authorities the following after-treatment methods are available:

a. **Selective Catalytic Reduction (SCR)**. These systems can reduce NOx exhaust over 90% by mixing the exhaust gas with ammonia (Urea 40% solution) and passing it through a special catalyst which breaks down the NOx into two components, nitrogen and water. This method is subject to maximum and minimum exhaust temperature constraints as well as the negative impact of high sulfur content of the fuel in initiating premature fouling of the catalyst. SCR manufacturer "Munters" which installed its first unit in 1991 has 170 units either in operation or on order on vessels trading mainly in European waters. For existing vessel conversions the SCR converter housing takes the place of the exhaust gas silencer. For new construction, designers should allow sufficient space in uptakes to accommodate the installation of the SCR converter, injection and mixing sections and urea storage tank. A diagram of an SCR system manufactured by Munters is shown in Figure 6.

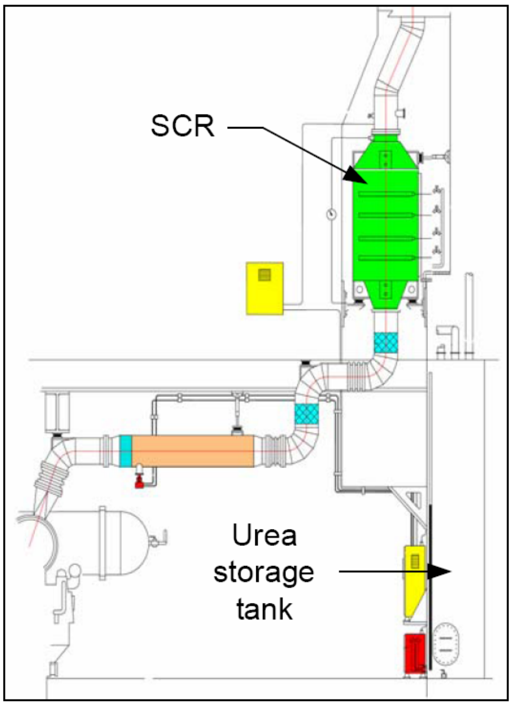

Figure 6 - SCR Converter Diagram (Munters)

b. **NOx scrubber systems** are designated exhaust gas cleaning systems (EGCS) by IMO resolution MEPC.130(53). The latter provides guidelines for certification by either, unit Type Approval and certification, or by continuous monitoring of SOx emissions. The EGCS is required to be capable of reducing emissions to no more than 6.0 g SOx/kWh through all loads. A concern of these systems addressed by Annex VI Reg. 14(4)(b) is that the waste streams are not to be discharged into enclosed ports, harbors or estuaries unless it can be demonstrated to have no adverse impact on the environment. For a comprehensive review of seawater scrubbers and their impact on the environment see Ref. 15.

4.3 Sulfur content in fuels

Worldwide limits on the maximum sulfur content in fuels used in all combustion equipment on board the ship, including boilers, are contained in MARPOL Annex VI Reg. 14. Presently this is set at 4.5% mass/mass. SECA's require the use of low sulfur fuels (1.5% maximum). IMO has been monitoring the worldwide sulfur content of marine fuels and the 2003 to 2005 rolling average was 2.7% based on results of 444,904 samples taken. This would indicate that the present refining and bunker system could handle a SOx limit lower than the current 4.5% worldwide average with present technology.

One method of dealing with this requirement is to carry the two grades of fuel onboard the vessel with low sulfur only utilized in SECA areas. There are a number of issues with the implementation of this method of compliance the principal of which are outlined below.

There are a number of issues for designers and owners to consider in operating with two fuel grades. Considering the physical aspects of tanks and piping:

a. Minimize cost of compliance by allocating one heavy fuel oil tank to low sulfur distillate fuel storage and then use common settling and service tanks. There is always the danger of incompatible fuels when distillate is mixed with heavy fuel oil. Hence, this requires that a well-defined procedure be in place for the blending of fuels in order that after a certain number of exchanges of the settling and service tank contents the low-sulfur limit is met. The mixing process can take several cycles of the settling tank to provide a 1.5% level of sulfur content in the service tank. When considering mixing, owners need to pay attention to the stability reserve of the heavy fuel oil they are considering to be mixed. If the stability reserve of the heavy fuel oil is low it cannot tolerate the mixing of more paraffinic distillate fuel since this will cause asphaltenes to precipitate out of the blend as a sludge, which will cause the fouling noted above. To avoid mixing problems owners should perform a compatibility test onboard or in the laboratory of their fuel oil testing service before mixing the fuels. Also, the size of the tanks, where different fuels are to be mixed, and the duration of the mixing should be minimized. The fuel blending procedure is to be fully documented as a part of the ship's operating procedures and appropriate fuel oil testing is to have taken place to prove sulfur limit compliance. Change over has to be well in advance of the entry to the SECA to fully complete the defined procedure and has to be documented in the Deck Log.

b. Modify the existing tank arrangement and associated piping to provide two separate systems. See Figure 7 for an example conversion, where one of the smaller HFO tanks is then used for low sulfur fuels. This avoids the requirement for mixing of fuels to obtain 1.5% sulfur content with attendant risks of clogged fuel filters, separators or sticking of fuel injection pumps.

c. For a new construction, ship designers should provide full duplication of fuel storage, settling, and service tanks together with separate piping to allow total segregation of high and low sulfur fuels. This provides for a rapid change over with only the high sulfur oil in the piping systems to be flushed out prior to burning low sulfur fuel.

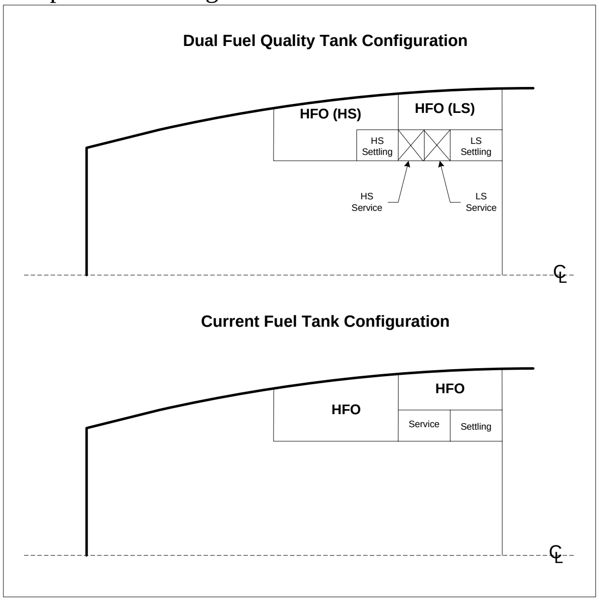

Figure 7 - Example of tank modifications

Then considering the operating aspects:

a. Lubricating oils are formulated to function with certain specification fuels i.e. a high sulfur fuel oil is associated with a different lube oil than a low sulfur fuel. Diesel engine lube oils with a high Base Number specification formulated to deal with high sulfur content residual fuels may cause hard calcium deposits on piston crown land during combustion of low sulfur fuel if a lower BN No. lube compatible with low sulfur fuel is not used after switch over to low sulfur fuel. Owners should verify the proper lube oil specification with the engine manufacturer and allow for storage of two grades of lube oil if they are switching from residual high sulfur oil to low sulfur fuel while transiting a SECA.

b. The mixing or blending of high sulfur content residual fuels with low sulfur distillate fuels has raised the issue of incompatibility and sludge build-up in filters, separators and fuel injection pumps.

c. Potential cavitation, wear or seizure problems with fuel injection equipment and engine performance issues of a minor or possibly major nature such as failure to develop full power after switching to run on low sulfur distillate fuel with low viscosity may occur.

d. Difficulty in obtaining bunker delivery notes has been reported. The regulation requires the registration of all bunker suppliers in ports of signatory states. IMO has acknowledged that there is a problem in obtaining the required documentation in some ports especially those of states that have not to date become signatories to the Annex VI convention. Owners have been encouraged to log instances and report issues to vessel flag states as well as the relevant port states. The Singapore administration, for example, has developed a standard for bunkering with a very clear illustration on how to take a correct bunker sample per Ref. 32.

For further details on low sulfur fuel usage see Ref. 16.

After treatment methods have been developed that will allow the continued use of high sulfur residual fuels. MARPOL Annex VI/Reg. 18 establishes requirements for the quality of fuels used onboard. Fuel quality is confirmed by the receipt and retention onboard of bunker delivery notes issued by the bunker supplier in the IMO required format and accompanied by a representative sealed oil sample signed off during each bunkering by both the supplier's representative and the responsible ships officer. The bunker delivery notice is required to be retained onboard for three years from delivery and the sample is to be retained until the associated fuel is substantially consumed but not less than one year.

A proposal for dealing with SOx emissions by burning distillate low sulfur fuels, first proposed by INTERTANKO, is gaining favor with other shipping groups and is included in the IMO agenda of measures to be considered in the Annex VI revision.

4.4 Update to Annex VI

As noted above IMO is actively working to revise MARPOL Annex VI and the associated NOx Technical Code. The results of the latest IMO Marine Environmental Protection committee meeting (MEPC 56) held in London from 9-13 July 2007 that relate to these revisions are noted below.

Expert Study Group Formed

Based on the recommendation of the IMO Secretary General, an informal Cross Government/ Industry Scientific Group of Experts is to be convened under the Chairmanship of the UK. This group will gather, evaluate and present facts to address the impact of the proposed fuel oil sulfur limit options, as outlined in the next paragraph to reduce SOx and particulate matter emissions generated by shipping, on the environment, human health, and shipping. The distillate fuel option if adopted would have a significant impact on the present refining, petroleum distribution and bunkering business, and has generated considerable discussion among the various stakeholders. The study group is scheduled to hold three meetings with a final report with recommendations to be submitted to the Bulk Liquids and Gases (BLG) sub- committee meeting in February 2008.

Sulfur Oxide (SOx) and Particulate Matter Emissions:

Listed below are the current sulfur content fuel options under consideration by IMO which prompted the formation of the Expert Study Group described above.

a. Option A: No change from current 4.5% and 1.5% limits. (not a viable option due to pressure from EU and USA environmental groups for tighter emission controls)

b. Option B: Keep or lower global SOx 4.5% limit and lower the SECA SOx limit in two tiers with

1.0% maximum effective 2010 and reducing to 0.5% in 2015.

c. Option B1: Within a defined distance from shore set a lower limit for SOx emissions or mandate the use of distillate fuels with a low sulfur level. Allow compliance through use of low-sulfur distillate fuel and/ or the use of exhaust gas cleaning technology . Also, limit particulate emissions

d. Option B2: Implement a global sulfur cap in two tiers commencing in 2012 with 3% cap followed by 1.5% cap in 2016 or allow use of residual fuel in association with alternative mechanisms such as SOx scrubbers to obtain equivalent levels of emissions. Additionally, manage the use of distillate fuel in SECA's, port areas and estuaries, with lowering of sulfur content to 1.0% in 2011 down to 0.5% in 2015 or utilize exhaust gas cleaning systems to reach equivalent levels of emissions.

e. Option C: Mandate the use of distillate fuels for all ships, with a global sulfur cap set at 1.0% by 2012, then reducing to 0.5% by 2015. A defined specification for the distillate fuel would need to be included in the regulation.

f. Option C1: Establish global caps as in option C above but allow for the use of residual fuel in combination with exhaust gas cleaning systems to obtain an equivalent level of emissions.

MARPOL Annex VI Revision Schedule

The Committee extended the schedule for completion of the revision of Annex VI by one year and agreed to hold an intercessional meeting of the BLG Air Pollution Working Group in late 2007 to be hosted by Germany. The results from this meeting and the Expert Study group will be sent to the BLG 12 sub-committee February 2008 meeting. The February meeting should finalize all technical revisions and report the outcome to MEPC 57 scheduled for April 2008. Final documents would be circulated for adoption at MEPC 58 in October 2008. The amendments to MARPOL Annex VI could enter into force 16 months after adoption. The following tasks requiring resolution will be considered by the BLG Working Group.

NOx Emissions from Existing engines:

Examine the feasibility of establishing NOx regulations for existing (pre-2000 yr. build) engines and develop a draft simplified certification scheme for existing engines to be incorporated as a new chapter in the NOx Technical Code. This may include requirements for retrofit kits of NOx critical components on certain high volume engines to be installed by a certain date or next scheduled major overhaul.

NOx Emissions from New engines:

Finalize the draft proposals for Tier II and Tier III NOx regulations for new engines. Tier I requirements are the current Annex VI Reg. 13 requirements.

Tier II requirements incorporate the best available in-engine NOx reduction technology including inlet air water injection, exhaust gas recirculation and turbo charger after cooling providing reductions of 15% to 25% depending on engine type with tentative implementation from 1 January 2011. The proposed NOx limits are as follows:

- 15-13.5 g/kWh for slow speed engines less than 130 rpm.
- Formula derived value for medium speed engines from 130 to less than 2000 rpm.
- 7.8-6.3 g/kWh for high speed engines over 2000 rpm.

Tier III requirements with a tentative implementation from 2015-2016, would necessitate further engine development or the use of after treatment technologies which is considered more likely. The NOx reduction options are as follows:

- Option X: 80% reduction from Tier I levels, using Selective Catalytic Reduction (SCR) after treatment or Humid Air Motor (HAM) technology within 50 nm of coast line.
- Option Y: 83%-85% reduction from Tier I levels, using after treatment (SCR) or HAM, applicable for large bore engines only in special NOx emission control areas (NECA's) near shore areas.
- Option Z: 30%-50% reduction from Tier I levels, utilizing advances in engine modifications or Exhaust Gas Recirculation (EGR) in conjunction with the use of MDO only as a global requirement for all engines.

Particulate Matter (PM) Reduction

Evaluate definition and measurement methods for setting possible PM limits for new and existing engines. The feasibility of introducing retrospective regulations to existing engines is considered a major challenge.

SOx Scrubber Wash Water Criteria

Review and finalize draft wash water criteria for Exhaust Gas-SOx Cleaning Systems (EGCS-SOx). A draft set of wetware criteria was developed for open ocean with a separate criteria for pH proposed for operations in ports, harbors, and estuaries where the greatest ecological impact could occur.

Guidelines for On-board Exhaust Gas –SOx Cleaning Systems

Review the draft amendments to the guidelines and finalize them as they are a significant improvement in organization and format over the current guidelines and were considered close to finalization.

Green House Gas Study (GHG) Study

The committee agreed to update the IMO GHG Study to provide a better foundation for future decisions and to take into consideration significant changes in the shipping industry and other global developments. The update is now scheduled to be completed no later than 2010. The study will update the current inventories and future scenarios of emissions of GHGs and other relevant substances from international shipping in order to access climate change and future emission potential.

Future Prospects
It is widely anticipated that a worldwide SECA area is implemented that would require burning low sulfur fuel or use of after treatment devices within a specified distance from shore. It is also widely anticipated that a full transition to the distillate fuel option is unlikely as there is too much impact on existing refining and distribution systems. Engine designers will continue to refine the combustion process to reduce NOx generation.

5. SOLAS

5.1 General

There are several germane upcoming changes for tankers, one now mandatory and the other in the process of development.

5.2 Gas detection

It is being proposed that oil tankers shall require fixed gas detection equipment for all ballast tanks, voids and any other tanks or spaces adjacent to cargo tanks, including the fore peak. Ships provided with inerting facilities for these tanks and spaces may adopt this practice as an alternative. Retrospective application is still under discussion.
Where detection equipment is adopted by a ship, the equipment provided shall measure flammable vapor concentration. For side ballast tanks up to two sampling points are likely to be required and one in double bottom tanks. A central gas analysis system, frequent sampling and visual and audible alarms are to be incorporated. The requirement for portable gas detection instruments will be retained.
This proposal was formulated by EMSA and submitted to MSC 82 (Ref. 17). The Fire Protection committee is responsible for progressing its development and it is likely that the earliest this will be proposed for approval is 2009 and several years thereafter before entry into force.

5.3 Inerting of cargo tanks on smaller tankers

The Inter-Industry Working Group has made a submission to MSC 82 recommending the adoption of inerting of cargo tanks in **oil and chemical tankers** smaller than 20,000 t dwt. This effectively closes the exemption for smaller ships in SOLAS II-2/4.5.5. Retrospective application is still under discussion.
The Fire Protection committee is responsible for progressing its development and it is likely that the earliest this will be proposed for approval is 2009 and several years thereafter before entry into force.

6. Other regulations

6.1 Anti-fouling coatings

The IMO Anti-Fouling Systems (AFS- Ref. 18) Convention requires that vessels shall not apply on or re-apply organotin compounds which act as biocides in anti-fouling systems. Panama verbally confirmed ratification at MEPC 56 in July 2007 hence, 12 months after written confirmation is received by IMO, AFS will enter into force. Similar EU regulations are in force prior to the convention being ratified (Ref. 19) EC Regulation 782/2003 prohibits organotin compounds being applied to ships and has been in force in Europe since 14 April 2003, with implementation from 1 July 2003. Hence, in the event a vessel is registered in an EU Member State or intends to trade within EU waters, compliance with the AFS Convention is required by 1 January 2008. The Regulation draws largely on the IMO’s AFS Convention and was implemented to encourage European member states to ratify this Convention. European-flagged ships now have to demonstrate compliance with this regulation by providing an AFS Certificate to EU member state port state control. A useful guide for survey and certification to comply with the IMO AFS Convention can be found in Ref. 20.
New advances in anti-fouling technology have resulted in improved biocide release systems and in foul release coatings which do not use biocides to control the fouling and the fouling organisms cannot adhere effectively to the paint surface. Shipowners should document the application of appropriate coatings to demonstrate compliance. ABS can assist ship owners by carrying out an AFS survey in accordance with this new resolution and issuing statements documenting AFS composition and application date.
MEPC 56 agreed a new work item - 'biofouling' i.e. invasive species carried on the hulls of ships.

6.2 Ballast water management (BWM)

An increasing number of port states worldwide require that vessels arriving in their waters should submit reports regarding their water ballast practice (Refs: 21 & 22). The background for this is problems experienced with harmful aquatic organisms spreading from one area to another through a ships’ ballast water system. Ballast water exchange in the open sea is deemed as an effective way of reducing the risk of transfer of harmful aquatic organisms and pathogens when it is necessary to discharge significant amounts of ballast water (e.g., tankers and bulk carriers) at the arrival port. Exchange is usually accomplished either by the sequential (drain and re-fill) or flow-through (circulate each tank with fresh ballast water at least three times tank capacity) method. Port states usually require a ballast water management plan to be carried on board. This plan shall comprise sufficient guidance to maintain normal operation within the normal sea limits in accordance with the ships’ loading documents or loading computer as well as any operating and safety precautions to be followed. Records of all ballast water exchanges are to be maintained on board.
MEPC 55 considered BW Exchange further and adopted several resolutions:

- BW exchange system design and construction guidelines (Ref. 23)
- sediment control guidelines (Ref. 24)

Each identifies practical actions for the designer and builder.
A number of US coastal states have legislated on BWM

requirements in excess of the IMO convention. The US Senate has passed a bill that will implement many of the requirements of the IMO Ballast Water Convention but with an added discharge standard 100 times greater than that stipulated in the IMO Convention. If technology is not available to meet this proposed standard, it may be allowed to default to the IMO standard. The US Environmental Protection Agency regulates this requirement in the US. The state legislation is subject to an on-going lawsuit. Confirmation of the regulations that will prevail are awaited.

Treatment Method (*Active Substance)	USD /m^3 of BW	Footprint m^2 @ Capacity (m^3/hr)
Hydro-cavitation	n/a	Fit in pipeline
Filtration*	0.40	5.8 @ 250
Cavitation/Ozone generator*	0.15 +	nominal
Filter/Electolytic Chlorination	n/a	70 @ 800
Magnetic filtration*	n/a	20 @ 50
Filter/Electolysis*	n/a	6 @ 500
Hydro-cyclone/Oxidizer*	0.30	17 @ 1000
Filtration/Disinfectant*	0.02	5 @ 300
Hydro-cyclone /UV	n/a	n/a
Electrolysis	n/a	9.5 @ 200
Cavitation/Ozone generator*	n/a	10 @ 1000
Cavitation/N_2 saturation	n/a	3m pipeline insert
Filtration / UV	n/a	2.6 @ 500
Filtration/Oxidation	0.06	22 @ 1200
+ US$ 1 million for installation n/a - not available		

Table 9 - Overview of treatment technologies

The intent of the IMO BWM legislation[4] (Ref. 25 Reg. B-3) is that from 2009 all new ships with a ballast capacity less than 5000 m^3 built in 2009 will need to be fitted with systems able to meet the performance standard specified in Ref. 22 – Reg. D-2 for limits on the quantity of harmful organisms present in ballast water. There are a number of BW Treatment systems (BWTS) in the process of Type Approval by ABS and other classification societies. At IMO the impediments to implementation of BWT systems (i.e., availability of type approved systems) are under debate and proposals are in hand for sampling methods and risk assessment in conjunction with exemptions. The MEPC.WP4 has produced a useful status report on ballast water technologies where 14 systems are summarized (Ref. 25) – see Table 9. There are two types of technology used for water treatment, either separation or disinfection. Most use two stages and a combination of the two technologies and almost all have been applied in land based utilities. The USCG is compiling a report on BWTS which is expected in August 2007.

From a design perspective the BWM convention Reg. B-3 introduces a ballast water capacity threshold for the compliance criteria:

- minimization of BW capacity to reduce costs of installation
- where the BW capacity of a new ship to be constructed in or after 2009 and before 2012 is close to 5000 m^3 the BW capacity may be increased to enable extension of the D-2 BWT compliance date to 2016. However, the ship will need to treat the water by exchanging ballast until 2016.

On the other hand, shipowners may consider it cost effective, where a suitable system is available, to install BWTS early to avoid retrofit at a later stage

Shipowners need to ensure that sufficient space is incorporated by designers to allow for BWTS installations at a later date in light of the retroactive measures for the fitting of such systems as contained in the BWM Convention. This is likely to be a major consideration for shipowners where shipbuilding contracts are already in place. In addition there are a number of issues in the Type Approval process that may cause delays in meeting the 2009 availability date. Consideration was sought at MEPC 56 for a delay of the implementation date due to the lack of type approved equipment and the uncertainty on the reliability of such equipment. No delay was granted due to lack of a legal framework to amend a convention not in force. 540 ships with a ballast capacity less than 5000 m^3 are estimated to be built in 2009 which will require systems to meet the Convention requirements. Further industry guidance will not be forthcoming until April of 2008 (MEPC 57).

IMO Legal Division has advised that, if the conditions for entry into force are not met by 31 Dec 2007, then the Convention would only enter into force after 1 Jan 2009, which in turn, would shift the first application date of the D-2 standard (1 January 2009) to the date of entry into force of the Convention i.e. not until 2014 or 2016 depending upon the ballast water capacity. Ships built on/after 1 January 2009 (keel laying) would be required to comply with the Convention when traveling to, or within the jurisdictional waters of, States that are signatory to the convention. Retrospective application is unclear, i.e. by what date must ships built after 1 January 2009 have the BWT systems fitted? This is dependant on interpretation by the State on the date of application.

6.3 Ship re-cycling

IMO Guidelines on Ship Recycling (Ref. 26) recommend that ships have a Green Passport in order to provide for safer and more environmentally-sound dismantling of ships. The Green Passport is essentially an inventory of materials present in a ship's structure, systems and equipment that may be hazardous to health or the environment. It is maintained throughout the ships' life.

[4] The BWM Convention will enter into force 12 months after being ratified by 30 states representing 35 per cent of the world's merchant tonnage. As of July 2007, 10 states (Barbados, Egypt, Kiribati, Maldives, Nigeria, Norway, St. Kitts & Nevis, Spain, Syria and Tuvalu), representing 3.42% of the world's tonnage, have ratified the BWM Convention.

Prior to scrapping, details of additional hazards in stores and wastes are added, and the document can then be used to help the recycling yard formulate a safer and more environmentally sound plan for decommissioning the ship.
As well as being an invaluable tool for the ship recycling yards, the Green Passport also helps to raise staff awareness of the materials on board a ship that may require special handling.
There are many unresolved practical implementation issues with this regulation.

6.4 Shore connections

Certain US ports are introducing the concept of cold – ironing where connection to shore-side power supply is made. Initial trials have been successful with containerships and cruise ships. However these ship types have a very different load requirement in port to a tanker which has to work cargo. There are many issues involved in the process such as connection types, transition loading and power requirements to name a few. Specialist advice can be provided by ABS should the owner need to consider this on the basis of the ports likely to be visited. It is unlikely that, until the many technical issues are resolved, shore connections will be included in MARPOL Annex VI. Work is underway in IACS, ISO and IEC to establish standards for high voltage shore connections.

6.5 Cargo tank coatings

Further to the submission to MSC 82 made by EMSA and various Non-Government Organizations (Ref. 27) a new SOLAS regulation has been proposed for the mandatory coating of the cargo tanks of oil tankers. An IACS joint-industry working group has subsequently been found to determine appropriate performance standards for cargo tank protective coatings. The standards will be submitted to the DE Sub-Committee for review in 2008.

6.6 Void space coatings

Performance Standards for Protective Coatings (PSPC) applying to Oil Tanker and Bulk Carrier void spaces located within the cargo block area and forward, have been developed and approved by IMO DE 50/WP 2. This will be put forward for adoption at IMO MSC 83 in October 2007.

7. Common Structural Rules

Another broad reaching change (class rules rather than regulation) affecting the design scantlings and new building processes for tankers is the advent of the IACS Common Structural Rules (IACS - Ref. 28), which are applicable to double hull oil tankers of 150m in length and above. While these Rules have been developed by IACS to determine the required hull structural scantlings for new construction, they are also tied in to two major new initiatives of the IMO, namely the IMO Performance Standards for Protective Coatings (PSPC - Ref. 29) and the IMO Goal-based New Ship Construction Standards (GBS).

7.1 Corrosion and coating protection

One of the major advances included in the CSR is the linkage of the assumed diminution of the structure used to determine the vessel strength at the design phase to the actual in-service thickness measurements which will be taken and assessed later in the operational phase of the vessel. This so-called net scantling concept seeks to base the strength of the design using critical load cases and assessment criteria such as strength and fatigue, while in an expected corroded condition. Therefore the overall average corrosion for hull girder cross-section and primary support members is given by simultaneously deducting half the local corrosion addition to replicate a 10 percent reduction of global strength.

The assessment of local scantlings is performed based on the superposition of stresses associated with the reduced hull girder properties and the local stresses associated with the local full deduction of the corrosion additions. In other words, the CSR assumes that the structure is corroded locally to the maximum allowed and the hull girder is reduced to the maximum allowed overall hull girder corrosion.

In addition to the adoption of this scantling concept, the CSR require that the PSPC be applied in order to delay the onset of corrosion in ballast tanks which constitute a major portion of a double hull tanker structure. Under CSR, the protective coating requirements apply to dedicated seawater ballast tanks in tankers of 150m in length and greater and to bulk carriers of 90m in length and greater, and to double-side skin spaces (other than dedicated seawater ballast tanks) arranged in bulk carriers of 150m in length and upwards. Under SOLAS II-1/3-2, the IMO PSPC is applicable for protective coatings in dedicated seawater ballast tanks of all types of ships of not less than 500 GT and double-side skin spaces (other than dedicated seawater ballast tanks) arranged in bulk carriers of 150m in length and upwards.

The early implementation by IACS of the PSPC was also based on feedback received from major shipowner's associations who insisted that the IACS CSR contain a detailed standard for coatings of ballast tanks. It should be noted that while the PSPC have been incorporated in to the CSR, the actual in-service wastage allowances are not permitted to be reduced due to the presence of the coatings.

The IMO PSPC contain requirements based on the Tanker Structure Cooperative Forum's (TSCF) coating specification, which includes extensive requirements for coating certification, surface preparation, coating application, inspection and measurements and finally the creation of a coating technical file to document each step of the process. ABS has developed a Guide which illustrates the ABS activities associated with the PSPC when applying the coating standards as a condition of classification associated with the CSR as well as when functioning as a Recognized Organization on behalf of Administrations. To indicate that a vessel has been coated in accordance with the PSPC, whether it is a CSR vessel or not, ABS will grant a “CPS” Notation (Ref. 31). It is understood that many of the other IACS members will be issuing notations as well.

Since IACS members are working with IMO and Administrations on the application of the PSPC as well as incorporating its use within the CSR, IACS members have worked together to develop a unified procedure to clarify many of the detail application issues not fully covered in the PSPC. These procedures have been included in IACS PR 34. It is envisioned that many of these procedures as well as feedback gained from the early application of the PSPC will be shared with the IMO.

Not withstanding the development of the PR 34, there have still been many detailed questions raised to IACS members regarding the application of the PSPC. IACS has endeavored to provide answers to these questions and provided free public access to the documented questions and answers via the IACS web site www.iacs.org.uk. In addition IACS has also formed an industry Joint Working Group (JWG) comprised of Class, owners, yards and coating experts in order to work together to further enhance and improve the coating standard and associated interpretations.

The impact on the shipbuilding process remains to be seen entirely. While some tanker owners have had detail painting specifications similar to the TSCF standards in their building contracts for some time now, others have not. Initial feedback from shipbuilders is that now with all tankers having to apply the PSPC there is a potential for weather conditions to affect building schedules, a new step for coatings to be certified, a high demand for certified coating inspectors, a large amount of increased documentation, and a potential new source of conflict between parties regarding compliance issues when delivering the vessel.

7.2 Structural Standard

Turning attention back to the CSR themselves, two sets of Common Structural Rules were developed by IACS; one for double hull oil tankers 150 meters in length and above; and the other for single or double side skin bulk carriers 90 meters in length and above. They represent complete Classification Society rules from the overall hull girder longitudinal strength and primary support members to local plating and stiffeners requirements. Papers have been written (Ref. 30) that generally describe the content, development process and maintenance procedures within IACS. For full details on the CSR the best source of information are the rules themselves (IACS – Ref. 28). These rule sets satisfy the stated main development objectives of increased:

(a) overall safety,

(b) robustness,

(c) durability, and,

(d) transparency.

One of the major factors included to meet these objectives was to base the rules on a 25 year design life based on the North Atlantic environment.

The impact studies performed by the Class Societies during the CSR development showed that scantling increases would be necessary to existing approved designs as a result of applying the new Rules. However, these existing designs were based on ships designed to the pre-CSR Rules and when the CSR investigation was performed it was assumed that all structural arrangements, spacing, weld seams, and most importantly material strength properties were kept the same as the original design. It was found that since the previously de signed vessels were designed to a range of pre-CSR classification requirements as well as having large variations of owner's extras that were applied in some of the previous designs, the steel weight impact results to bring these designs to the common structural requirements varied significantly.

At the time, the steel weight increase range quoted by IACS members as well as shipyards themselves varied anywhere between 3 to 12 percent. Shipyards are now beginning to review the new CSR in association with brand new design offerings having differing cargo capacities, building strategies, yard block lifting capacities, and automated weld capabilities. The yards are now starting to offer these new designs using the CSR as a base.

While reviewing the scantlings associated with these new designs may give a more accurate representation of the final CSR-based impacts on the designs, it makes it more difficult to compare these new designs with pre-CSR designs which had different loading capacities. A generalized comparison still indicates a wide spread in comparisons and there is generally a significant increase in steel weight in most designs. General trends can be seen in the locations where the CSR increase scantlings over existing pre-CSR designs - see Figure 8.

Another factor affecting the differences in scantlings or pure steel weight is whether the new designs include a greater percentage of higher tensile strength (HTS) steel. The CSR do not set a fixed maximum percentage on the use of HTS steel like some owner-specified contract clauses do. However, the CSR includes requirements associated with the most relevant failure modes such as strength (e.g. yielding, ultimate strength and buckling) and fatigue, which factor in the material strength properties. Therefore, especially with respect to buckling fatigue and the wastage allowances, the CSR particularly account for HTS. Of course the pre-CSR always accounted for HTS with respect to strength or yielding requirements. The overall result of increased percentage on HTS in designs is a lesser steel weight increase than previously reported, but they still result in general more robust and durable ships with regard to steel weight.

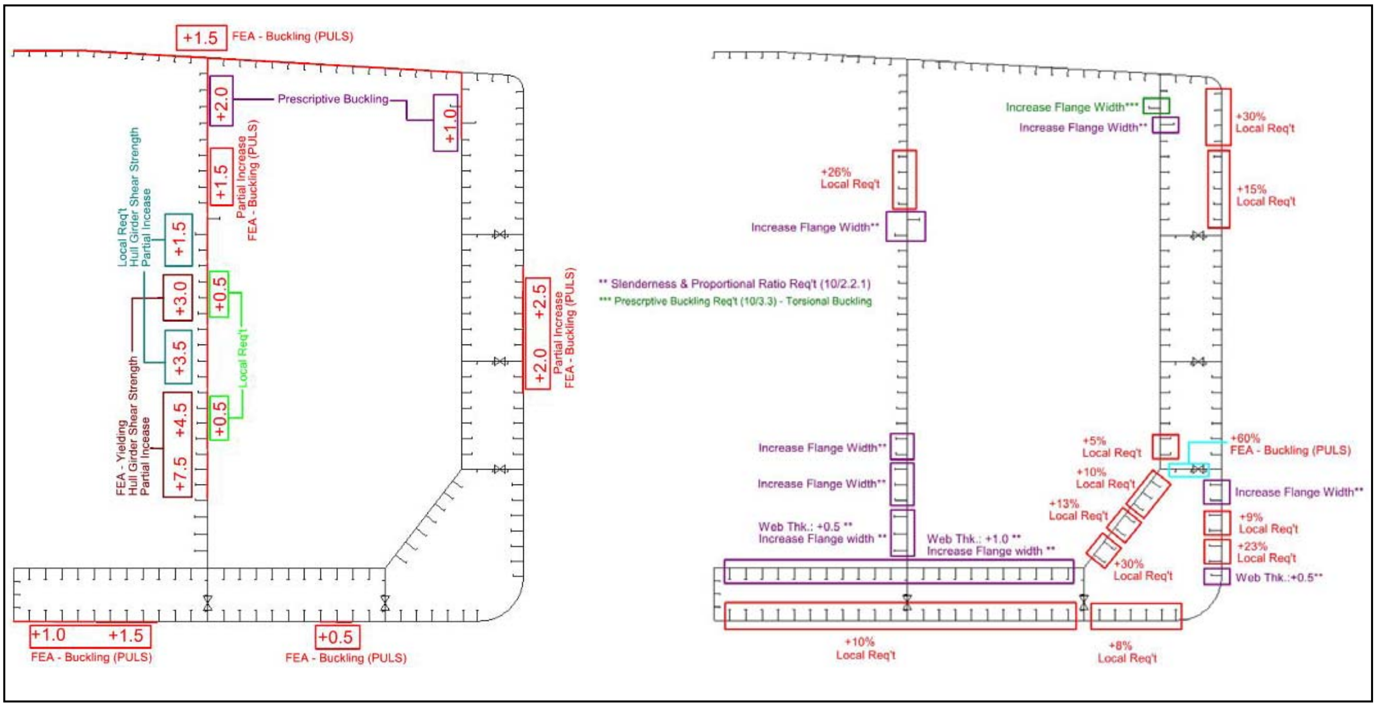

Fig. 8 - Typical scantling increase trends for VLCC longitudinal plating and stiffeners

The CSR's include a more stringent fatigue criterion associated with the 25 year design life and North Atlantic environment. This more stringent criterion tends to counteract the increased use of HTS material since the higher HTS materials do not increase the fatigue capability of welded structures. Therefore the structural details are being designed and fitted more carefully. It is anticipated that structures less prone to fatigue failure will be constructed.

7.3 Future Developments

The CSR were developed over a number of years and were subjected to considerable feedback from all aspects of industry. The feedback spanned the range from comments indicating that the new standards have been increased too much to comments that they have not been raised enough. Technical specialists have also commented that some of the simplifications that are typically present in Rules have been overly simplified, while others have commented that the Rules are too complicated. Comments have been received that there are too many design load cases to consider and other comments have indicated that during the consolidation of the design load cases important ones have been eliminated.

IACS has continued to respond to all feedback and has recently announced a new organization of Groups responsible to improve the response to these feedback items. These Groups will continue to work on the planned harmonization of the tanker and bulk carrier CSRs as well as be responsible for maintenance and new developments as necessary.

8. Conclusions

The set of changes to the regulatory and classification regime summarized here are those in motion at this time. Typically regulation is introduced and then refined over time – the management of engine room oil waste is a good example.

One could suggest that there has to be a point at which the application of more regulations becomes counterproductive. Have we arrived at that point ? Probably not. Then what of the future? Do we expect more regulatory changes? Will we see Common Rules for other ship types? Will we see a framework of even stricter control to minimize pollution and maximize safe operations? There seems to be no doubt about the direction, the only question is the speed at which we arrive there and the measures that are introduced on the way.

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