THE ERA OF GROWTH

From the 1950s, tanker size increased substantially as the world demand for oil escalated. The previous 'standard' tanker of 12,000 dwt was superseded, initially by a class of 16,000 to 18,000 dwt vessels, and in 1954 the launch of the Lloyd's Register-classed *Tina Onassis*, 45,230 dwt, continued the rapid growth in ship size. By the end of the 1950s the 100,000 dwt mark had been surpassed. This continued in the 1960s with the arrival of the supertanker. These vast vessels were first developed for the Middle East to Japan route, which placed no physical limitation on size, in comparison to routes to Europe using the Suez Canal. Following the closure of the canal in 1967 for six years, tankers bound for Europe had to round the Cape of Good Hope, so the restrictions imposed by the dimensions of the Suez Canal ('Suezmax') no longer applied. Then in 1973, war in the Middle East, followed by the quadrupling of oil prices by the OPEC countries, brought economic growth to a standstill and new orders of tankers dried up. However, while the supertanker building boom lasted, hundreds of these ships were built to Lloyd's Register as 100A1 'Carrying Petroleum in Bulk', was one of the first tankers built with tanks completely extending to the side shell. The *Gluckauf*, which was launched one week earlier, is generally accepted to be the first tanker of modern design, where the liquid cargo is contained directly in the hull. Purpose-built tankers had arrived and would steadily increase in number over the next 20 years.

THE INTRODUCTION OF LONGITUDINAL FRAMING

Radical changes in construction came in 1906 when Joseph Isherwood, a naval architect who was employed by Lloyd's Register between 1896 and 1907, invented the Isherwood System of Longitudinal Framing. In 1908, *Paul Paix* (4,196 grt) was the first ship to be built to this design and to be classed by Lloyd's Register with the notation “Longitudinal Framing”. The following year, Lloyd's Register accorded full recognition to the advent of the tanker by publishing separate *Rules for the Construction of Vessels Intended for the Carriage of Petroleum in Bulk*.

The 1880s witnessed the beginnings of what was to become, arguably, the most important ship type of all in terms of global industrial development: the oil tanker.

As early as the 1870s, three passenger/oil steamers had been built to Lloyd's Register class – *Vaderland* (2,748 grt), *Nederland* (2,839 grt) and *Switzerland* (2,816 grt) – with tank arrangements comparable to those of later more sophisticated tankships. These ships were designed to carry both passengers and oil in bulk (rather than in barrels), but the authorities thought this too dangerous and hence these vessels were only permitted to carry general cargo. However, oil had become an important commodity, and in 1886, the 1,669 grt *Bakuin*, classed with Lloyd's Register as 100A1 ‘Carrying Petroleum in Bulk’, was one of the first tankers built with tanks completely extending to the side shell. The *Gluckauf*, which was launched one week earlier, is generally accepted to be the first tanker of modern design, where the liquid cargo is contained directly in the hull. Purpose-built tankers had arrived and would steadily increase in number over the next 20 years.

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LLOYD’S REGISTER HULL CLASS NOTATIONS

- This distinguishing mark will be assigned, at the time of classing, to new ships constructed under Lloyd’s Register Special Survey, in compliance with the Rules, and to the satisfaction of the Committee.

100 This character figure will be assigned to all ships considered suitable for sea-going service.

A This character letter will be assigned to all ships which have been built or accepted into class in accordance with Lloyd’s Register’s Rules and Regulations, and which are maintained in good and efficient condition.

I This character figure will be assigned to: (a) Ships having on board, in good and efficient condition, anchoring and/or mooring equipment in accordance with the Rules. (b) Ships classed for a special service, having on board, in good and efficient condition, anchoring and/or mooring equipment approved by the Committee as suitable and sufficient for the particular service.

LLOYD’S REGISTER TANKER HULL TYPE NOTATIONS

Chemical Tanker, Ship Type ( ) (*)

- Designed for the carriage of chemicals (including petro-chemical products) having significant fire hazards in excess of those of petroleum and similar flammable liquids, or significant hazards in addition to or other than flammability (i.e. reactivity, corrosiveness, toxicity). The list of products will be stated on the International Certificate of Fitness. Type 1, 2 or 3 where an IBC Code Certificate of Fitness has been issued by Lloyd’s Register. Type 1*, 2* or 3* where an IBC Code Certificate of Fitness has been issued by the appropriate National Authority.

Double Hull Oil Tanker

- Designed with integral cargo tanks, for the carriage of oil having a flash point not exceeding 60°C (closed cup test). Except indicated otherwise in the Rules the cargo tanks are to be bounded by side and bottom dedicated water ballast tanks or void spaces constituting a double hull for the ship.

Double Hull Oil and Chemical Tanker Ship Type ( ) (*)

See Double Hull Oil Tanker above. The list of products will be stated on the International Certificate of Fitness.

Oil or Bulk Carrier

- Designed to carry oil in bulk having a flash point not exceeding 60°C (closed cup test) or dry bulk cargo alternatively. The structural configuration is similar to a double-hull bulk carrier.

Oil Tanker

- Designed as a conventional single-hull sea-going tanker having integral cargo tanks, for the carriage of oil having a flash point not exceeding 60°C (closed cup test).

Ore or Oil Carrier

- Designed to carry oil in bulk having a flash point not exceeding 60°C (closed cup test) or dry bulk cargo alternatively. The structural configuration is similar to a double-hull ore carrier.

Computer-based frame analysis was in its infancy, and the days of finite element analysis were still far off. These ships pushed the boundaries of shipbuilding knowledge and posed structural problems on a scale never previously experienced, such as the stresses produced within such large hulls by ‘hoggging’ and ‘sagging’ in waves and ‘sloshing’ of the liquid cargoes.

INCIDENTS AND REGULATION

With the growth of tankers came the increased risk of large-scale pollution following an incident, and the world began to see catastrophic pollution caused by tanker incidents – an early example being the 1967 grounding of Torrey Canyon, resulting in a spill of 124,000 tonnes of cargo which remains the sixth largest oil spill in history.

Over the last 20 years there have been several defining moments when major disasters have resulted in significant legislative actions affecting the technical standards applied in tanker design.

The Exxon Valdez incident in 1989 resulted in the Oil Pollution Act 1990 and later IMO Regulation 13G/F mandating the introduction of double hulls for tankers. Erika in 1999 resulted in the mandatory phase-out of single-hull tankers and more recently, the Prestige in 2002 further accelerated pending legislative changes. These step changes, in addition to many other advances in tanker design and shipping regulation, have brought about a massive improvement in tanker safety since the introduction of the supertanker. This can clearly be seen in the INTERTANKO statistics shown in the chart. But the industry can always do more, and further regulations and advances in tanker design are always being introduced.

COMMON STRUCTURAL RULES

The ensuing industry, political and environmental pressures from the Erika incident led to an agreement in 2001 to collaborate on a common Rule set for tankers between the three major tanker classification societies Lloyd’s Register, ABS and DNV, who together class approximately three out of every four tankers in the world.

The common Rule objectives were to:

1) avoid competition between classification societies on minimum structural requirements as a result of the application of different society’s rules
2) to raise the standard of robustness by increasing the requirements for strength allowed for ships in operation
3) to raise the standard of durability by developing transparent requirements for fatigue assessment and corrosion allowances
4) to provide a clear link between design requirements and the requirements for ships in operation.

As of April 1, 2006 any tanker over 150 metres in length carrying crude oil or products contracted for construction with any of the 10 IACS classification societies is required to be designed and constructed in accordance with these common structural Rules. The introduction of these Rules has seen an increase in the total steelweight used to build tankers. This is because the strength models used for scant-
<table>
<thead>
<tr>
<th>Feature Notations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BLS Bow Loading System</strong></td>
<td>Assigned to tankers equipped with bow loading arrangements to facilitate the transfer of cargo oil from offshore loading terminals.</td>
</tr>
<tr>
<td><strong>Carriage of Oils with an F.P. not exceeding 60°C</strong></td>
<td>Assigned to non-oil tankers where the ship is suitably constructed and arranged for the carriage of oils with a flash point not exceeding 60°C (closed cup test).</td>
</tr>
<tr>
<td><strong>Carriage of Oils with an F.P. exceeding 60°C</strong></td>
<td>Assigned where only the carriage of oils having a flash point exceeding 60°C (closed cup test) is contemplated.</td>
</tr>
<tr>
<td><strong>CR Corrosion Resistant</strong></td>
<td>Assigned where cargo tanks are either constructed of, or lined with, corrosion-resistant material. The corrosion-resistant material will be specified in brackets.</td>
</tr>
<tr>
<td><strong>CSR Common Structural Rules</strong></td>
<td>Assigned to double-hull oil tankers which fully comply with the Common Structural Rules.</td>
</tr>
<tr>
<td><strong>EP (A), (B), (G), (N), (O), (P), (R), (S), (V) Environmental Protection</strong></td>
<td>Assigned when the requirements for the arrangement and equipment for environmental protection, covering the major area of concern with regard to operational pollution from shipping, have been complied with. Additional requirements are set down for the assignment of supplementary notations.</td>
</tr>
<tr>
<td><strong>ESP Enhanced Survey Program</strong></td>
<td>Assigned to oil tankers, combination carriers, chemical tankers, which are subject to an enhanced survey program.</td>
</tr>
<tr>
<td><strong>Helicopter Landing Area</strong></td>
<td>Assigned where a helicopter landing area is provided.</td>
</tr>
<tr>
<td><strong>Ice Class</strong></td>
<td>Assigned where a ship is strengthened to navigate in specific ice conditions.</td>
</tr>
<tr>
<td><strong>Ice Class ID</strong></td>
<td>1D = First year ice conditions in areas other than the Northern Baltic. The requirements for Ice Class ID are for ships intended to navigate in light first-year ice conditions. The requirements for strengthening the forward region, the rudder and steering arrangements for Ice Class 1C FS are applicable.</td>
</tr>
<tr>
<td><strong>Ice Class IAS FS, IA FS, IB FS, IC FS (+) - draughts xx Power required xx kW, Power installed xx kW</strong></td>
<td>Ships that comply with the requirements of the Finnish Swedish Ice Class Rules in force at the time of contract and Section 7, for Ice Class IA Super, IA, IB and IC may be assigned the corresponding notations. The Finnish Swedish Ice Class Rules may be obtained from the following website: <a href="http://www.fma.fi">www.fma.fi</a>.</td>
</tr>
<tr>
<td><strong>Ice Class AC1, AC1.5, AC2, AC3</strong></td>
<td>Arctic or Antarctic Ice Conditions equivalent to unbroken ice with a thickness of 1.0m. 1A = thickness of 0.8m. 1B = thickness of 0.6m. 1C = thickness of 0.4m. (FS) indicates compliance with the requirements of the Finnish Swedish Ice Class Rules in force at the time of midship section approval. (+) indicates with additional powering requirements.</td>
</tr>
<tr>
<td><strong>Winterisation H(Tx)</strong></td>
<td>Assigned for ships designed with hull construction materials for low temperature operations. Tx denotes the design air temperature.</td>
</tr>
<tr>
<td><strong>Winterisation A(Ty), B(Ty), C(Ty)</strong></td>
<td>Assigned for ships designed with equipment and systems for low temperature operations. Ty denotes the design air temperature. Winterisation level A denotes ships intended for prolonged duration in low temperatures. Winterisation Level B denotes ships intended for seasonal duration in low temperatures. Winterisation Level C denotes ships intended for short duration in low temperatures.</td>
</tr>
</tbody>
</table>

| Independent Tanks | Assigned to tankers where the tanks are independent of each other. It is only used when some of the tanks are not independent. |
| **IWS In-Water Survey** | Assigned where an In-Water Survey will be accepted in lieu of the intermediate docking between Special Surveys required in a five-year period when the ship complies with the following: rudder pintle and bush clearances and the security of the pintles can be verified afloat. Stern bush clearances can be verified afloat. High-resistance paint applied to the underwater part of the hull. |
| **LI Loading Instrument** | Assigned where an approved loading instrument has been installed as a classification requirement. |
| **MARPOL 13G(1)(c)** | Assigned to double-hull oil tankers not meeting the Rule minimum double side width requirements but which comply with MARPOL Regulation 13G (1)(c). |
| **Pv (maximum permissible positive pressure/vacuum relief valve setting** | Assigned where the maximum permissible positive pressure/vacuum relief valve setting for which scantlings have been approved is greater than 0.21 bar gauge, e.g. pv = 0.4 bar gauge or > 50 kPa. |
| **Sandwich Construction (pt)** | Assigned when the vessel has been partly built using sandwich construction. |
| **ShipRight (ES )** | Assigned when scantlings in excess of the approved Lloyd’s Register Rule minimum are fitted at defined locations. |
| **ShipRight SDA Structural Design Assessment** | This notation will be assigned when direct calculations in accordance with the ShipRight procedures have been applied. Mandatory for oil tankers over 190 meters in length which are not designed and constructed in accordance with the Common Structural Rules (CSR). |
| **ShipRight FDA Fatigue Design Assessment** | This notation will be assigned when an appraisal has been made of the fatigue performance of the structure in accordance with the ShipRight procedures. Mandatory for oil tankers over 190 meters in length which are not designed and constructed in accordance with the Common Structural Rules (CSR). |
| **ShipRight CM Construction Monitoring** | This notation which complements the ShipRight SDA, ShipRight FDA and ShipRight FDA plus notations, will be assigned when the controls in construction tolerances detailed in the ShipRight procedures have been applied and verified. Mandatory for oil tankers built to both Common Structural Rules and Lloyd’s Register’s Rules for non-CSR tankers. |
| **SG () (in) (tanks) Maximum permissible relative density** | Assigned when the maximum permissible relative density (specific gravity) for which scantlings have been approved is greater than 1.025, e.g. SG 2.0. |
| **SLS Stern Loading System** | Assigned to tankers equipped with stern loading arrangements to facilitate the transfer of cargo oil from offshore loading terminals. |
| **SPM Single Point Mooring** | Assigned to a ship provided with additional mooring arrangements which enable it to be moored at a single point mooring. |
| **TLS Submerged Turret Loading System** | Assigned to tankers equipped with submerged turret loading systems to facilitate the transfer of cargo oil from offshore loading to terminals. |
The carriage requirements of many chemicals and II and the IBC Code will have a substantial effect on tanker operations. Effective on January 1, 2007 the recent amendments to MARPOL 73/78 Annexes I and II and the IBC Code will have a substantial effect on tanker operations. The carriage requirements of many chemicals will change and a new four-category pollution

**FUTURE REGULATION/STANDARDS**

In the future, the development of regulations and standards aimed at improving the level of safety on tankers shows no sign of slowing.

**MARPOL Annexes I and II**

Effective on January 1, 2007 the recent amendments to MARPOL 73/78 Annexes I and II and the IBC Code will have a substantial effect on tanker operations.

Eleo Maersk, classed with Lloyd’s Register, was the world’s first double-hull VLCC.
categorisation system will be introduced to replace the current five-category system.

Improvements in ship technology, such as efficient cargo tank stripping systems, have made it possible to significantly lower permitted discharge levels of certain products which have been incorporated into Annex II. For ships constructed on or after January 1, 2007 the maximum permitted residue in the tank and its associated piping left after discharge will be set at a maximum of 75 litres for products in categories X, Y and Z - compared with previous limits which set a maximum of 100 or 300 litres, depending on the product category.

Alongside the revision of Annex II, the marine pollution hazards of thousands of chemicals have been evaluated by the Evaluation of Hazardous Substances Working Group, giving a resultant GESAMP2 Hazard Profile which indexes the substance according to its bio-accumulation; bio-degradation; acute toxicity; chronic toxicity; long-term health effects; and effects on marine wildlife and benthic habitats.

One result of the hazard evaluation process and the new categorisation system is that vegetable oils, which were previously categorised as being unrestricted, will now be required to be carried in chemical tankers.

In association with Lloyd's Register
Oil fuel tank and pump room bottom protection
These regulations extend the double-hull principle to oil fuel tanks (which on large tankers can contain thousands of tonnes of oil fuel) and cargo pump rooms. The cargo pump room regulation is aimed at preventing the cargo pump room from becoming inoperable in the event of a grounding so that the vessel retains the ability to pump/transfer cargo from one tank to another to minimise the impact of a grounding and the scale of any resulting pollution.

The regulation applies to the cargo pump rooms of oil tankers of 5,000 dwt and above constructed on or after January 1, 2007.

The pump room shall be provided with a double bottom of a height not less than:
- \( h = \frac{B}{15} \) metres \((B = \text{breadth})\) or
- \( h = 2 \) metres

whichever is the lesser. The minimum value of \( h = 1 \) metre.

The fuel oil tank protection regulation applies to all vessels (not just tankers) with an aggregate oil fuel capacity of 600 cubic metres and above delivered on or after August 1, 2010 as defined below:

- building contract placed on or after August 1, 2007 or;
- if no contract, keels laid on or after February 1, 2008 or;
- the delivery of which is on or after August 1, 2010.

It will also apply to vessels which undergo a major conversion in accordance with the above dates.

The regulation will apply to all oil fuel tanks except those designated as ‘small’ oil fuel tanks (i.e. those having an individual capacity of less than 30 cubic metres), provided that the aggregate capacity of such excluded tanks is not greater than 600 cubic metres. Individual oil fuel tanks shall not have a capacity over 2,500 cubic metres. Ships can comply by satisfying one of two criteria.

The first of these requires that tanks shall be located inboard of the bottom and side shell plating, creating a double hull around the tanks. Alternatively, ships may satisfy the second criterion by meeting an accidental oil outflow performance standard, which aims to limit the potential for fuel loss.

Access to shore-based emergency response
Following the grounding of the bow Empress in Milford Haven and the resultant pollution, the UK Government recommended to IMO’s Marine Environment Protection Committee (MEPC) that regulations be brought into force to help ensure that remedial actions such as lightering could be carried out in a rapid and controlled fashion following a grounding or collision without compromising structural strength or stability. MEPC subsequently adopted a new regulation 37(4) which will enter into force on January 1, 2007. The regulation states that: “All oil tankers of 5,000 tons deadweight or more shall have prompt access to computerised, shore-based damage stability and residual strength calculation programs.”

Tanker operators can comply with the new regulation by enrolling their ships with Lloyd’s Register EMEA’s ship emergency response service (SERS), which has earned a reputation as the leading provider of marine emergency response worldwide. The number of ships enrolled in the service recently passed the 2,000 mark, which includes approximately 1,000 tankers.

Emission regulations and SECAs
MARPOL Annex VI entered into force on May 19, 2005. Regulation 14 requires that the sulphur content of any fuel used onboard ships does not exceed 4.5% by mass. The sulphur content of any fuel used onboard ships operating in a sulphur emission control area (SECA) must not exceed 1.5% by mass.

Two SECAs are currently identified by Annex VI: the Baltic Sea area, which became effective as a SECA on May 19, 2006, and the North Sea area, which will become effective on November 22, 2007. EU directive 2005/33/EC will enforce sulphur emission controls in the same areas, as well as introduce some additional measures on the use of low-sulphur fuel. The directive will apply to all ships, regardless of flag.

As an alternative to using fuel with a 1.5% sulphur content, ships may use an exhaust gas cleaning system or other technological method to limit the emission of sulphur oxides. Such systems and technologies must be approved to the IMO standard contained in MEPC.130(53).
FUTURE CHALLENGES FOR THE TANKER INDUSTRY

Operating in arctic environments

In recent years there has been an increasing demand for tankers to navigate in cold regions. One reason for this is the emergence of new trade routes in cold regions, such as Sakhalin, which pose new design challenges. Many features fitted to these ships to combat low temperatures and icing are in addition to ice-class requirements, and these are based on experience of operations. Not all owners and builders have experience of designing for cold and ice environments. Such knowledge is generally experience based and dependant on the ship arrangement, trade route and ship size. For example, the ship size and hull form will dictate the ship motions and the amount of spray, and, hence, the amount of icing on the deck.

Additionally, the trade route will determine the sea states encountered and the level of spray. There is a need to capture this knowledge and ensure that it is applied to new designs. Accordingly, Lloyd’s Register’s winterisation Rules have been developed to provide a standard of protection against cold temperatures and the effects of icing on the operation of the ship (see Winterisation H(Tx) and Winterisation A(Ty), B(Ty), C(Ty) notations).

Coatings

In May 2006, the 81st session of IMO’s Maritime Safety Committee (MSC 81) drafted amendments for SOLAS regulations II-1/3-2 and XII/6.3 with a view to their being adopted at MSC 82. The major thrust of this work was the drafting and agreement of the Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks (‘the Ballast Tank Standard’) in all ships and the double-side skin spaces of bulk carriers.

The Ballast Tank Standard provides technical requirements for protective coatings in steel seawater ballast tanks at the new construction phase, aiming to give coatings a target life of 15 years. The standard addresses several stages: coating system approval; surface preparation and application requirements; inspection; maintenance of records; and verification. If adopted at MSC 82 in December 2006, compliance with the Ballast Tank Standard will be mandatory where any of the following is satisfied:

- newbuild contracted on or after July 1, 2008 (but see below)
- in the absence of a building contract, keel laid on or after January 1, 2009
- delivery on or after July 1, 2012.

However, compliance with the Ballast Tank Standard will also be mandatory for tankers over 150 metres in length that are contracted on or after the date of adoption and built in accordance with the common structural Rules.

Tempero and Mastera, both Lloyd’s Register class, are the world’s first Aframax ice-class 1A5 oil tankers; they are also the world’s first double-acting tankers. Pictured here, Mastera.
**Human element**

As may be noted from recent tanker casualty statistics, a large proportion of all tanker incidents continue to be 'operational', i.e. collision or grounding and arguably a much greater percentage have a human element within their root cause. Therefore, possibly the greatest challenge facing the tanker industry today is the recruitment, training and retention of the officers and crew onboard tankers who are collectively responsible for delivering a large proportion of the world’s energy.

The global world tanker fleet continues to expand, with the world orderbook over the current decade maintaining levels of around 25% of the existing tanker fleet.

**Working against this are a number of factors:**

1. It continues to become more and more difficult to attract people from both developed and developing nations to a career at sea.

2. The growth of the world LNG fleet is seeing some of the most experienced tanker officers leaving the tanker fleet and joining the gas fleet.

3. The continuing increase of regulatory, quality system and third-party inspections by oil majors, flag states, port states, charterers, terminals, consultants and class societies adds to the work load of all onboard and leads to increased fatigue.

The International Labour Organisation will shortly introduce new minimum requirements for seafarers on ships and minimum conditions of employment, including minimum hours of rest. So not only is the number of crew members required to man the world’s tanker fleet increasing but so also is competition for the existing supply of experienced and qualified tanker officers and crew.

Lloyd’s Register is helping to address these issues by working with the Nautical Institute, among others in the industry, to raise awareness about the importance of the human element through research and development projects and publications such as *Alert!*, circulated within MER on a quarterly basis for the last three years. Publication of *Alert!* will continue over the next three years, beginning in January 2007.

As the tanker sector moves forward, it has become unavoidably apparent that if we are to continue to make measurable safety improvements, the focus will have to expand to include the human element, as well as the technical aspects of the ship.

For further information contact Nick Brown, Business Manager - Tankers, Lloyd’s Register Email: nicholas.brown@lr.org