Regulatory developments and their practical implementation in today’s rapidly developing OSV & tug markets

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SYNOPSIS

In this paper the key developments with respect to rules and regulations for Offshore Support Vessels, as well as their impact on the OSV industry, will be presented. The current regulations related to safety, environmental and labour issues which are relevant to OSVs are addressed. A detailed overview of recent developments of the existing regulations as well as the regulations currently under development is provided, with a particular focus on the OSV Design & Construction Guidelines, the LHNS Guidelines, the SPS Code, the preparation of new regulations covering anchor handling operations, environmental regulations (MARPOL Annex VI, BWM Convention), the Maritime Labour Convention (MLC) and STCW Convention (crew training & certification). In addition, the practical implementation of these regulations into the classification rules of Bureau Veritas is addressed in order to provide ship owners, shipyards and designers with a clear insight into how they can cope with the regulatory challenges the OSV industry is facing.

From a technical point of view the OSV and tug industry are related due to the fact that offshore support vessels are regularly engaged in towing operations, which is specifically the case for anchor handling tug supply vessels, tug supply vessels and offshore terminal tugs engaged in offshore berthing assistance and escort towage. In that respect it is important to take note of development regarding tug regulations. Comparison of the existing tug rules of different classification societies shows that there are considerable differences in requirements. The same can be said of the statutory requirements of flag states, in particular for non-Convention vessels (tugs of less than 500 gt). This provides challenges for tug owners, builders and designers. In response leading class societies Bureau Veritas, Lloyd’s Register of Shipping and American Bureau of Shipping have launched a joint effort to develop safety guidelines for design and construction of tugs, which focus on key issues such as towing & escort stability, towing equipment & safety equipment. To this end a new set of class notations is proposed with the goal of creating a comprehensive regulatory framework in support of the tug industry, which is expected to be of use to the OSV industry as well.

INTRODUCTION

This section describes the current status of the OSV market, as well as the ongoing developments which are driving the regulatory changes discussed in the remainder of this part of the paper. Today’s fleet of Offshore Support Vessels (OSV) consists of more than 8,000 ships, representing a gross tonnage of more than 10m gt. The average ship age is slightly over 20 years. The breakdown of the fleet in the segments Anchor Handling Tug Supply (AHTS) vessel, Platform Supply Vessel (PSV), support vessel, research vessel and standby-safety vessel is shown in Figure 1.

Considerating year-on-year development of the fleet between May 2009 and May 2010 it is observed that the OSV fleet has grown by more than 10% in numbers and, importantly, by more than 20% in terms of gt.
These growth figures indicate that the newbuilding market is very active and that there is a tendency towards building larger ships. This trend is also confirmed by Clarkson, reporting slightly over 700 OSVs on order, which is about 9% of the in service fleet, but representing 2.2m gt, which is more than 20% of the in service fleet (CRS, April 2010). Figure 2 shows the orderbook distribution over the different OSV segments. Clearly, the market for relatively complex (multifunctional) AHTS vessels has significantly gained importance in the recent past, mainly at the expense of the more simple PSVs.

Figure 2: World OSV orderbook by vessel type in number of ships (Source: CRS, April 2010)

Figure 3 shows the distribution of the OSV orderbook over the top 20 of ordering countries and building countries, respectively (in number of ships as well as in gt). At this moment Singapore is the number one ordering country with 24 companies mainly focusing on AHTS vessels, while Norway, USA and France remain strong ship ordering countries. In Norway 36 companies are investing mainly in large PSVs, hence the number one position in terms of tonnage. Brazil is the runner up and is expected to grow further due to the massive increase of the offshore oil & gas industry. Other countries coming up are China, India, Germany Malaysia and the UAE, largely fuelled by domestic growth of the offshore oil & gas business (except Germany, which is more focused on chartering vessels to actual operators).

Figure 3: World OSV orderbook by distribution over top 20 ship owner (left) and builder (right) countries

On the shipbuilding side China is convincingly number one. India is growing fast, building both for domestic clients as well as foreign account. South-East Asia remains a strong building cluster, in particular for the
smaller OSVs. Brazil is also coming up as a ship building country due to the required local content to be included in building up the Brazilian OSV fleet. Norway and the USA mainly consider the domestic market, while Spain is looking at export.

In line with the statistical data described above one of the most noticeable developments in the market is the growth of Brazil as ship owning and building country, which comes along with the expansion of offshore oil & gas industry in Brazil (Petrobras). Deep water oil & gas exploration and production requires large number of floating drilling and production units, which in turn creates strong demand for OSVs designed for installation, supply, anchor handling and maintenance. The continued expansion of the oil & gas related offshore activity in other regions, in particular in the Arabian Gulf, South East Asia, Mediterranean, Black Sea & Caspian Sea, as well as the arctic & sub-arctic regions, also pushes the OSV market forward.

The general perception in the OSV market is that oil majors chartering OSVs, as a consequence of their risk management strategy, are pushing for higher specifications and therewith drive the demand for ever more sophisticated ships with higher specifications, e.g. in terms of required power and redundancy of Dynamic Positioning (DP) systems, etc.

Another important tendency is related to the continuous development of more complex chemical products to enhance the effectiveness drilling mud & brines and other process liquids used by the offshore industry. Newly developed products involving chemicals need to be carefully assessed in order to determine their potential hazards to safety (e.g. flammability and toxicity) and the environment (pollution risk) and evaluate the necessary conditions for carriage in supply vessels. Additionally, in the aftermath of the accident with the Bourbon Dolphin in 2007 a clear focus on operational safety and enhanced designs of anchor handling tugs has emerged in the market. The key points are related to stability during anchor handling operations and winch performance, in particular the emergency quick-release. Consequently, a new generation of anchor handling tugs is being developed (e.g. by Ulstein and Rolls Royce, Guido Perla and Wärstilä/Conan Wu).

Along with the other maritime industry the OSV market is looking at reducing the environmental impact of air emissions by focussing on fuel consumption reduction as well as the application of alternative powering systems. In the North Sea basin supply vessel running on gas fuelled engines have are being introduced, while hybrid vessels, making use of a combination of gas engines, fuel cells and batteries are under development and testing. Hybrid diesel-electric power systems on OSVs allow for a significant reduction in fuel consumption and exhaust gas emissions as the operational profile of many OSVs is such that the power demand is relatively small during a large percentage of the operational time. When power demand is low several large generators can be switched off) enabling the operational gensets to operate at sufficiently high load levels to be close to their optimum efficiency), while fuel cell power systems can generate electric power at near zero emission levels.

Specific operational conditions require specifically designed vessels. With the offshore oil & gas industry moving further into deep water and the regions with ice and cold weather conditions, more specialised and sophisticated OSVs are being developed. A new generation of Inspection, Maintenance and Repair (IMR) vessels is under construction, specifically aiming at deep water operations. For working in ice and cold weather conditions OSVs need reinforced structures to be able to cope with the ice pressures generated as well as proper winterisation to make sure that equipment is working and ice accretion can be controlled. A special case is the oil & gas rich North Caspian Sea, an area of shallow water (generally the water depth is less than 5 m) which freezes in winter time (up to 80 cm level ice thickness, which is very strong due to the low salinity of the water). Specially designed shallow draught ice breaking tug supply vessels are under construction for this area. For OSV operations in arctic conditions with heavy ice conditions Polar Class vessels are required. In addition, special consideration with regard to the protection of these environmentally highly sensitive areas is mandatory.

Finally the fall-out of the Gulf of Mexico disaster with the Deepwater Horizon rig will have to be considered, as it is expected to significantly impact the oil & gas industry and therewith also the OSV industry. In the immediate aftermath of the disaster several countries have suspended or restricted further deep water drilling, while inspection regimes are being enhanced. A further development towards more safety regulations and more compliance verification may be expected, taking into account the lessons learnt from the disaster. Such developments may lead to an increased demand for deep water OSV vessels, in particular for IMR, well intervention, oil recovery and standby-safety.
OSV REGULATORY DEVELOPMENTS

OSVs have been subject to compliance with a large number of general and dedicated regulations. The key international regulations and guidelines applicable to OSVs are listed in Table 1. The subsequent sub-sections describe the key developments in relation to safety (design, construction and operation), environmental protection (and energy efficiency) and labour issues.

Table 1: Key international regulations & guidelines for OSVs

<table>
<thead>
<tr>
<th>Regulation/Standard</th>
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<tr>
<td>SOLAS Convention (≥ 500 gt)</td>
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<tr>
<td>MARPOL Convention</td>
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<tr>
<td>International Load Line Convention (ILLC, L ≥ 24 m)</td>
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<tr>
<td>IMO Res. MSC.235(82), adopted 1 December 2006</td>
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<tr>
<td>Guidelines for the Transport and Handling of Limited Amounts of Hazardous and Noxious Liquid Substances in Bulk on Offshore Support Vessels (LHNS Guidelines)</td>
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<tr>
<td>IMO Res. A.673(16), adopted on 19 October 1989, Amended by IMO Res. MSC.236(82), adopted 1 December 2006</td>
</tr>
<tr>
<td>Code of Safe Practice for the Carriage of Cargoes and Persons by Offshore Supply Vessels (OSV Code)</td>
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<tr>
<td>IMO Res. A.863(20), adopted 27 November 1997, Amended by IMO Res. MSC.237(82), adopted 1 December 2000</td>
</tr>
<tr>
<td>Code of Safety for Special Purpose Ships (SPS Code), 2008</td>
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<tr>
<td>IMO Res. MSC.266(84), adopted 13 May 2008, Previously IMO Res. A.534(13), adopted 17 November 1983</td>
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<tr>
<td>Guidelines for Vessels with Dynamic Positioning (DP) Systems</td>
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<td>IMO MSC/Circ.645, adopted 6 June 1994</td>
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<td>Guidelines for Dynamic Positioning System (DP) Operator Training</td>
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<tr>
<td>IMO MSC.1/Circ.738/Rev.1, adopted 7 July 2006 (Reference to IMCA Training and Experience of Key DP Personnel (Issue 1/Rev.1))</td>
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<tr>
<td>Code of Safety for Diving Systems, 1995</td>
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<tr>
<td>IMO Res. A.831(19), adopted 23 November 1995</td>
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<td>Ballast Water Management Convention, 2004 (not yet in force, pending ratification)</td>
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<tr>
<td>Maritime Labour Convention, 2006 (not yet in force, pending ratification)</td>
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<tr>
<td>Standards of Training, Certification &amp; Watchkeeping (STCW)</td>
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Developments related to safety regulations

OSV Design & Construction Guidelines

The OSV Design & Construction Guidelines, 2006, are applicable to offshore supply vessels with keel laying date on or after 1 June 2007. The requirements cover (intact and damage) stability, machinery and electrical equipment, fire protection, life-saving appliances and radiocommunications, as well as a reference towards the LHNS Guidelines for the transport of hazardous and liquid noxious substances in bulk.

The key developments of the OSV Design & Construction Guidelines are related to stability requirements, which are mandatorily applicable to vessels with a length (L, defined in accordance with the ILLC) of 24 m and over. The guidelines make reference to the Intact Stability Code, 2008, IMO Res. MSC.267(85). This code covers the latest generation of intact stability criteria and specifically addresses offshore supply ships and special purpose ships, including the alternative stability criteria for offshore supply vessels with characteristics rendering compliance with the standard intact stability criteria impracticable and a requirement for a minimum freeboard at the stern of at least 0.005L to be maintained in all operating conditions. It should however be noted that the code does not include any specific stability criteria in relation to towing (prevention of girding) and anchor handling operations and that stability of OSVs undertaking such activities should be specifically considered. As a general comment, the minimum required initial metacentric height criterion (GM₀ = 0.15 m) should not be considered to provide sufficient stability margin for ships engaged in towing and anchor handling operations. For a discussion on towing stability reference is made to [1]. For a discussion on anchor handling stability reference is made to the sub-section anchor handling guidelines below.
With regard to damage stability requirements, which follow the deterministic approach, side damage is now assumed to occur anywhere in the vessel’s length between transverse watertight bulkheads with the following extent of damage:

- **Longitudinal:** $3L/100 + 3$ for $L > 43$ m, while $L/10$ for $L \leq 43$ m;
- **Transverse:** $0.76$ m (measured inboard from side perpendicular to the CL at summer load waterline);
- **Vertical:** full depth (from underside of cargo deck or continuation thereof).

Theoretically this implies a 2-compartment damage standard (used to be 1-compartment standard), which may have consequences for existing designs depending on the length of the ship and the chosen watertight subdivision.

**LHNS Guidelines**

The LHNS Guidelines are applicable to offshore supply vessels with keel laying date on or after 19 April 1990. The requirements cover the transportation of limited amounts of hazardous and noxious liquid substances in bulk on offshore support vessels. The aggregate quantity of bulk liquids is to be less than 800 m$^3$ and not to exceed a volume equal to 40% of the vessel’s deadweight calculated at a cargo density of 1.0 t/m$^3$, considering:

- Hazardous and noxious liquids provided in Appendix 1 of the guidelines and those other products which may be assigned to the appendix based on the following criteria:
  - Products which for safety reasons may be assigned for carriage on a Ship Type 3 (IBC Code) and which are not required to meet the requirements for toxic products (IBC Code, Sec 15.12);
  - Noxious liquid substances which would be permitted for carriage on a Ship Type 3 (IBC Code);
- Flammable liquids.

Specific requirements are provided in relation to stability and cargo tank location, ship design, pollution prevention, personnel protection and operational requirements and regularly refer to the IBC Code. Requirements for existing ships are included in a separate chapter.

Key developments of the LHNS Guidelines (LHNS = Liquid Hazardous and Noxious Substances) include the reference to the IMDG Code (IMDG = International Maritime Dangerous Goods) for dangerous goods in packaged form, as well as updated reference to the four pollution category system of MARPOL Annex II:

- **Category X:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and, therefore, justify the prohibition of the discharge into the marine environment;
- **Category Y:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment;
- **Category Z:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment; and
- **Other Substances (OS):** substances which have been evaluated and found to fall outside Category X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning of deballasting operations. The discharge of bilge or ballast water or other residues or mixtures containing these substances are not subject to any requirements of MARPOL Annex II.

In addition, a completely new list of products (Appendix 1) has been issued which contains 32 products, whereas the 1989 edition of the LHNS Guidelines contained only 10 products. Particular new products on the product list, shown in Figure 4, include oil- and water-based mud (containing mixtures of products listed in chapters 17 and 18 of the IBC Code and the MEPC.2/Circular and are permitted to be carried in accordance with the LHNS Guidelines) and drilling brines.

It is important to note that the identification process for Noxious Liquid Substances (NLS) carried in bulk but not listed in Appendix 1 is carried out by the IMO Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships (EHS) under the responsibility of the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP). Referring to the market developments described in the introduction section, this working group is to evaluate newly developed products in terms of product category designation and to determine the applicable conditions for transportation in liquid bulk
(tankage required). Depending on the chemical composition of the product and the safety risks posed to human life and the environment it may or may not be carried on board offshore support vessels. For ships specifically engaged in contracts for the transportation of special products it is recommended to check the status of the envisaged products in a very early stage to check the applicable transportation requirements.

The LHNS Guidelines also cover the carriage of higher quantities of NLS in for well stimulation vessels under the condition that the damage stability criteria of the OSV Design & Construction Guidelines, 2006, can be complied with assuming damage to occur anywhere in the vessel’s length at transverse watertight bulkheads, theoretically imposing a 3-compartment damage standard.

In relation to the pollution requirements a Cargo Record Book, Procedure, Arrangements Manual and Shipboard Marine Emergency Plan are to be developed in accordance with MARPOL Annex II. Discharge into the sea of residues of noxious liquid substances permitted for carriage in Ship Type 3 ship, products listed in Appendix 1 or ballast water, tank washings or other residues/mixtures containing such substances is prohibited. Reception facilities in port to be used for discharge of residues and mixtures containing noxious liquid substances. MARPOL Annex II requirements for efficient striping may consequently be waived. The guidelines also refer to the additional application of MARPOL Annex I requirements in case cargoes regulated by MARPOL Annex I (oil products & fuel oils) are carried.

**Anchor Handling Guidelines**

As indicated in the sub-section on the OSV Design & Construction Guidelines there are currently no specific internationally applicable stability requirements for vessels engaged in anchor handling operations. Following the disaster with the AHTS vessel "Bourbon Dolphin", which capsized in April 2007 in the North Sea a number of initiatives has been taken to improve design and operational safety of anchor handlers, specifically considering stability and the performance of anchor handling winches. Most notably, the
Norwegian Maritime Directorate (NMD) has issued Guidelines on the implementation of specific measures to ensure a sufficient safety level during anchor handling operations carried out by supply ships or tugs:

- NIS/NOR Circ 7/2007, 7 September 2007;

The IMO Sub-Committee on Stability and Load Lines and on Fishing Vessels Safety (SLF) has included a work programme item on minimum residual stability during anchor handling operations as well as other operations where vessels are subject to similar large external forces, which is lead by the delegation of Norway and expected to be submitted to Maritime Safety Committee (MSC) in December 2010.

The NMD Circular requires that, for vessels that are used for anchor handling and which at the same time are utilizing their towing capacity and/or traction power of the winches, calculations are to be made showing the acceptable vertical and horizontal transverse force/tension to which the vessel can be exposed. The calculations are to consider the most unfavourable conditions for transverse force/tension and as a minimum include the following:

- Calculations performed for the maximum acceptable tension in wire/chain, including the maximum acceptable transverse force/tension that can be accepted in order for the vessel’s maximum heeling to be limited to one of the following angles, whichever occurs first:
  - Heeling angle equivalent to a righting lever (GZ) value equal to 50% of the maximum righting lever (GZ\(_{MAX}\));
  - The angle which results in water on working deck when the deck is calculated as flat;
  - 15 degrees;
- The heeling moment is to be calculated as the total effect of the horizontal and vertical transverse components of force/tension in the wire or the chain;
- The torque arm of the horizontal components shall be calculated as the distance from the height of the work deck at the guide pins to the centre of main propulsion propeller or to centre of stern side propeller if this projects deeper, see Figure 5;
- The torque arm of the vertical components shall be calculated from the centre of the outer edge of the stern roller and with a vertical straining point on the upper edge of the stern roller, see Figure 5.

The calculations are to be performed for typical anchor handling conditions, including intermediate conditions. Prevailing practice with regard to loads on deck and winch reels is to be taken into account. The vertical tension force is to be included in the loading conditions, upon which calculations of trim and curve for righting arm are based.

In addition to the calculations, information stating the maximum force/tension in wire or chain, as well as the corresponding angle of deviation (indicated as \(\theta\) in Figure 5) in accordance with the calculations, must be communicated to the vessels crew and be displayed next to the control desk or at another location where the navigator on duty easily can see the information from his command post. The displayed information must be in the form of curves prepared so that the master can easily determine the maximum forces that can be applied to the vessel, as a function of displacement/draught and vertical centre of gravity (VCG) so that the stability criteria are satisfied. An example of such curve is given in Figure 6.
The guidelines also address the towing and anchor handling equipment. The effect of emergency release on winches and equipment is to be reviewed and procedures for unintended situations are to be established. For each type of equipment emergency (quick-)release methods, time delays and release speed are to be described and associated procedures are to be communicated to the vessel’s crew. Vital information on safe operation is required to be displayed next to the control desk or another appropriate location on the bridge where the navigator on duty easily can see the information from his usual command post.

In addition specific requirements for tandem operations are provided, including quick disconnection in case of breakage of towline or loss of power/bollard pull in one vessel. Also, the effect of roll reduction tanks on stability during anchor handling operations and the effects of fuel consumption during operations (change of ship displacement (draught and trim) are to be considered. In particular, a fuel consumption plan with documentation for fuel oil and ballast water (sequence for emptying and filling tanks, taking into consideration free surface moments) as to be provided. Quite obviously, the guidelines also require the preparation and documentation of anchor handling procedures, including emergency procedures.

While it is generally recognised that significant progress has been made, some issues need to be considered in more detail. One of the main points is how the crew on board can determine whether or not they are operating within the safe operating area of the maximum tension diagram, see Figure 6. In order to determine that, the crew needs to know the loading condition of the ship (in order to select the correct diagram), the line tension and the angle of deviation. In reality the loading conditions is well known, but in many cases the line tension is not measured and the angle of deviation can only be estimated on the basis of crew judgement, possibly enhanced by angle indicators on the working deck. This means that it is by no means easy to “know where you are” during operation. A second point is related to the determination of the available bollard pull during actual operation at sea. Anchor handling vessels are generally advertised with the maximum bollard pull achieved during a standard bollard pull test in port. When operating at sea in waves and current, various (electrical) power consuming equipment, such as thruster units controlled by the DP system, may be operational. Depending on the powering arrangement these additional consumers may take their power from the same source as the ship’s main thrusters, therewith effectively reducing the available bollard pull and consequently the anchor handling capacity. An anchor handling vessel with sufficient bollard pull for a certain job based on a standard bollard pull test may therefore prove to be unsuitable and unsafe for performing the rig actual job at sea, as it cannot handle the total weight of wire/chain and anchor. From these points it becomes clear that the key issue for safe and effective anchor handling operations is a proper planning and preparation of the operation, including the selection of a suitable ship for the job, taking into consideration local conditions (water depth, wire/chain length and weight, anchor weight, waves, current, etc.) and ship characteristics. The scope of such planning is to prevent the anchor handling vessel from getting into a potential hazardous situation.
Another point of concern is whether or not it is necessary to include an additional stability criterion regarding the minimum required residual area between the righting and heeling lever curves after their first intersection point (static angle of equilibrium). A proposal for a minimum residual area 0.055 m rad, calculated from the first intersection point of the righting and heeling lever curves up to the minimum of the second intersection point, angle of (down)flooding or 40 degrees is being considered by the NMD [2]. This criterion has been developed on the basis of the towing stability criteria introduced given in IACS Rec. 24 “Intact Stability”. ¹

With the widening involvement of IMO, class societies, ship owners and designer it is expected that the current guidelines will be further developed in order to mature in the form of internationally applicable regulations. It is generally considered that the industry through these developments will achieve a higher safety standard and therefore reduce safety, operational and financial risks.

**SPS Code**
The Code of Safety for Special Purpose Ships, 2008, or SPS Code, is applicable to new ships of 500 gt and over and with more than 12 special personnel for particular operational duties of the ship (in addition to the ship’s crew for normal navigation, engineering and maintenance or persons engaged in crew services). Special personnel are not considered as passengers (due to their knowledge of ship layout, training in safety procedures and handling of safety equipment). Therefore special purpose ships do not need to fully comply with all SOLAS requirements for passenger ships. In fact, the scope of Code is to provide equivalent level of safety compared to SOLAS. A key point is that the determination of the entry into force date is left to the discretion of the Administration (no definition of “new ship” in the SPS Code). It is to be noted that the SPS Code may also be applied to non-Convention vessels.

Typical ship types to which the SPS Code is applied include offshore support vessels (including diving support vessels, stand-by rescue/salvage vessels, research/expedition/survey vessels (e.g. seismic, oceanographic, fishery, arctic)), cable and pipe laying vessels, crane ships, fish factory ships, training ships and accommodation barges.

The specific requirements cover stability and subdivision, machinery installations (steering gear), electrical installations (emergency source of power, precautions), periodically unattended machinery spaces, fire protection, dangerous goods, life-saving appliances, radiocommunications, safety of navigation and security. Actual SOLAS requirements are applicable depending on the number of special personnel.

The major change in the 2008 edition of the SPS Code concerns stability and subdivision. First of all, the damage stability requirements are in accordance with the probabilistic methodology of SOLAS Ch II-1, where the ship is considered as a passenger ship (special personnel are considered as passengers). To this end the required subdivision index \( R \), to be calculated in accordance with SOLAS Reg. II-1/6.2.3, is as follows:

- \( R \) for ships certified to carry 240 persons or more;
- \( 0.8R \) for ships certified to carry not more than 60 persons;
- Linear interpolation between \( 0.8R \) and \( R \) is to be applied for ships certified for more than 60 but not more than 240 persons.

In accordance with SOLAS requirements calculations also to be performed for intermediate stages of flooding, while the maximum heeling moment due to wind, crowding of passengers or launching of survival crafts is to be included.

Another important requirement is related to the double bottom, as additional deterministic damage stability calculations assuming bottom damage are to be performed if the double bottom height is less than \( h = B/20 \) m, where \( h \) is to be not less than 0.76 m and does not need to be taken as more than 2.0 m. In the formula \( B \) denotes the ship’s moulded breadth, in m.

In the “old” SPS Code, IMO Res. A.534(13), the damage stability requirements follow the deterministic approach in a similar way as the OSV Design & Construction Guidelines. As the SPS Code, 2008 is aligned with the latest SOLAS requirements for passenger ships this change in requirements is very significant and needs to be carefully considered by designers, preferably at an early stage of the project.

¹ Background information on towing stability criteria is provided in [1].
More in general, it is to be noted that the lower limit for the number of special personnel on which the technical requirements are based has changed from 50 to 60 persons, while the upper limit has changed from 200 to 240 special persons.

**Developments related to environmental protection regulations**

**MARPOL Annex I Oil Fuel Tank Protection**

Oil fuel tank protection is regulated by MARPOL Annex I Reg 12A, IMO MEPC.141(54), which entered into force on 1 August 2007. The requirements are applicable to all ships with an aggregate oil fuel capacity of more than 600 m³ and:

- contract date on or after 1 August 2007, or
- keel laying date on or after 1 February 2008, or
- delivery date on or after 1 August 2010, or
- having undergone a major conversion.

Oil fuel tanks with capacity of more than 30 m³ need to be protected, or, alternatively, compliance with a performance standard for accidental oil fuel outflow is to be demonstrated. In addition, a maximum capacity limit of 2,500 m³ per oil fuel tank is given.

Protection of oil fuel tanks means that they oil fuel tanks are to be located above the moulded line of the bottom shell plating nowhere less than the distance h as specified follows:

- $h = \frac{B}{20}$ m or,
- $h = 2.0$ m,

whichever is the lesser, while the minimum value of $h = 0.76$ m, see Figure 7 (left side). In the above formula B denotes the moulded breadth, in m. In addition, the oil fuel tanks are to be located inboard of the moulded line of the side shell plating, nowhere less than the distance $w = 0.4 + \frac{2.4C}{20,000}$ m (measured at any cross-section at right angles to the side shell), while the minimum value of $w = 1.0$ m for for individual tanks with an oil fuel capacity of 500 m³ or more and $w = 0.76$ m for individual tanks with an oil fuel capacity of less than 500 m³, see Figure 7 (right side). In the formula C denotes the ship’s total volume of oil fuel, including that of the small oil fuel tanks, in m³, at 98% tank filling.

![Figure 7: Definition of inboard distances for oil fuel tank protection](image)

As a consequence of this regulation the general arrangement design of ships with an aggregate fuel oil capacity of more than 600 m³ has changed in order to create the required protection against oil fuel outflow due to damage. For the same main dimensions this results in a loss of bunker capacity and/or cargo carrying capacity (additional double-skin void spaces or ballast tanks) and increased building cost (due to additional tank bulkheads and/or increased main dimensions in order to maintain the bunker and cargo carrying capacity.

Although MARPOL Annex I Reg. 12A considers oil fuel tanks only, it is common practice for modern OSV designs to also protect the oil cargo tanks. In addition, it is reminded that the minimum inboard distance of cargo tanks containing products covered by the LHNS Guidelines is 0.76 m from the side of the vessel perpendicular to the centreline at the level of the summer load waterline.

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2 Valid for ships with an aggregate oil fuel capacity of 600 m³ or more but less than 5,000 m³.
Revised MARPOL Annex VI and NOx Technical Code

The Revised MARPOL Annex VI and NOx Technical Code have entered into force on 1 July 2010. The scope of the requirements is to limits nitrogen oxide (NOx) emissions for diesel engines ≥ 130 kW for new ships with constructed on or after 1 January 2000 and existing ships constructed between 1 January 1990 and 1 January 2000, to limits sulphur oxide (SOx) emissions globally and in designated Emission Control Areas and to prohibit deliberate emissions of ozone depleting substances including halons and chlorofluorocarbons (CFC).

In Table 2 the applicable standard for NOx emissions is shown, while Table 3 and Figure 8 present the NOx emission limits as function of the engine speed in rpm. It is to be noted that engines used only in emergency are exempted from the requirements and that application of exhaust gas treatment systems is considered an acceptable solution for complying with the emission limits.

Amendments adopted during MEPC 58 (October 2008) allow the designation of Emission Control Areas (ECAs) for SOx and particulate matter (PM) or NOx or all three types of emissions. A proposal for the designation of an ECA by IMO is to be formulated by one or more countries that have ratified MARPOL Annex VI and is to be justified by a need to prevent, reduce and control the emissions in the concerned area. At this moment the designated Emission Control Areas are the North Sea/English Channel and the Baltic Sea, while MEPC 60 (March 2010) adopted amendments to Regs. 13 and 14 and a new Appendix 7 to formally establish a North American Emission Control Area (off the Pacific coast of the USA and Canada and off the Atlantic coast of the USA, Canada and France (Saint-Pierre-et-Miquelon)). The expected date of entry into force is 1 August 2011. Near future ECAs may include the Mediterranean Sea, Black Sea and port areas with heavy traffic.

### Table 2: Applicable standard for NOx emissions

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<tr>
<th>Engine fitted on a ship constructed at date D *</th>
<th>Applicable standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2000 ≤ D &lt; 1/1/2011</td>
<td>Tier I</td>
</tr>
<tr>
<td>1/1/2011 ≤ D &lt; 1/1/2016</td>
<td>Tier II</td>
</tr>
<tr>
<td>D ≥ 1/1/2016</td>
<td>Tier III in ECA</td>
</tr>
<tr>
<td>&quot;existing engines&quot;</td>
<td>Tier II elsewhere</td>
</tr>
<tr>
<td>1/1/1990 ≤ D &lt; 1/1/2000</td>
<td></td>
</tr>
<tr>
<td>cylinder volume ≥ 90 l &amp; output &gt; 5,000 kW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tier I</td>
</tr>
</tbody>
</table>

* MARPOL: construction date = keel laying date

### Table 3: NOx emission limits

<table>
<thead>
<tr>
<th>Engine rpm N</th>
<th>N &lt; 130</th>
<th>130 ≤ N &lt; 2000</th>
<th>N ≥ 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier I</td>
<td>17.0 g/kWh</td>
<td>45N^{0.80} g/kWh</td>
<td>9.8 g/kWh</td>
</tr>
<tr>
<td>Tier II (≈ 80% Tier I)</td>
<td>14.4 g/kWh</td>
<td>44N^{0.80} g/kWh</td>
<td>7.7 g/kWh</td>
</tr>
<tr>
<td>Tier III (≈ 20% Tier I)</td>
<td>3.4 g/kWh</td>
<td>9N^{0.20} g/kWh</td>
<td>2.0 g/kWh</td>
</tr>
</tbody>
</table>

Figure 8: NOx emission limits
The generally applicable limits related to SOx emissions in terms of sulphur content (measured by mass) are as follows:

- maximum sulphur content of 4.5% before 1 January 2012;
- maximum sulphur content of 3.5% starting 1 January 2012;
- maximum sulphur content of 0.5% starting 1 January 2020: subject to a feasibility review to be completed not later than 2018 in order to respond to objections raised by the refining industries; should the review conclude negatively, the effective date would be 1 January 2025.

Within ECAs the sulphur content limits are as follows:

- maximum sulphur content of 1.5% before 1 July 2010 or, alternatively, installation of an exhaust gas cleaning system achieving a total SOx emission ≤ 6.0 g SOx/kWh;
- maximum sulphur content of 1.0% starting 1 July 2010 or, alternatively, installation of an exhaust gas cleaning system achieving a total SOx emission ≤ 4.0 g SOx/kWh;
- maximum sulphur content of 0.1% starting 1 January 2015 or, alternatively, installation of an exhaust gas cleaning system achieving a total SOx emission ≤ 0.4 g SOx/kWh.

In addition, it should be noted that other national or regional regulations apply. In Europe (ref EU 2005/33/EC) the maximum sulphur content in an ECA is 1.5% (may be lowered to 0.5% in the future), while at berth the maximum sulphur content is 0.1% (entry into force 1 January 2010). Alternatively, cold ironing may be applied while at berth. The California Air Resources Board (CARB) has also adopted strict sulphur content regulations, which apply to main and auxiliary engines and to auxiliary boilers of ships operating within 24 miles from the coast, as shown in Table 4.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Date of entry into force</th>
<th>Type of fuel and permitted sulphur content</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1/7/2009</td>
<td>marine gas oil (DMA) with sulphur content ≤ 1.5% or marine diesel oil (DMB) sulphur content ≤ 0.5%</td>
</tr>
<tr>
<td>II</td>
<td>1/1/2012</td>
<td>marine gas oil (DMA) or marine diesel oil (DMB) with sulphur content ≤ 0.1%</td>
</tr>
</tbody>
</table>

The above described regulations also impact OSVs, in particular those vessels operating within ECAs, such as the North Sea and off the US coast in the Gulf of Mexico. In relation to NOx emissions the first next step is Tier II (keel laying date on or after 1/1/2011). This target can be managed without problem, as most engine manufacturers have already developed Tier II compliant engines. The Tier II standard is typically achieved by modification of existing engine designs by applying combustion optimisation, fuel injection optimisation, common rail technology, turbo-charging and charge-air after-cooling or modified valve timing (Miller Cycle). However, with engine modifications alone it is not possible to achieve the Tier III standard. This means that exhaust gas treatment by Selective Catalytic Reduction (SCR) will be necessary, which requires a significant amount of space on board (equipment, urea tank), as well as high capital expenditure. This may prove to be an issue for relatively small OSVs with limited available space. At the same time engine manufacturers are developing technologies to further reduce NOx emissions without after treatment, such as Exhaust Gas Recirculation (EGR) and Humid Air Motor (HAM).

With respect to the sulphur emissions a choice is to be made between bunkering low sulphur fuel complying with the applicable sulphur content limit or applying exhaust gas treatment by means of scrubbers. Also here there may be issues with available space (scrubber installation or multiple bunker, day and settling tanks) as well as cost (scrubber equipment (high capital expenditure) or low sulphur fuel (high operational expenditure)).

An alternative way of complying with the stricter emission limits would be to switch to gas propulsion, as LNG does not contain sulphur and NOx emission reductions of more than 80% can be achieved (Tier II compliant).

**Greenhouse Gas Emissions & Energy Efficiency**

Up to now greenhouse gas (GHG) emissions from shipping have not been regulated at the international level. It is important to acknowledge that maritime transport is today the most energy efficient means of transport of goods per tonne mile and to recognise that air emissions of shipping, in terms of tonne CO₂,
emitted per tonne transported cargo, have come down by 70% since 1950 [3]. However, the continuous growth of the world seaborne trade would lead to a significant increase of emissions by international shipping if no global emission control policies are implemented. Therefore, IMO has been engaged in discussions on how to control GHG emissions from shipping for quite some time now, and voluntary guidelines and instruments to reduce CO₂ emissions for new designs, as well as new and existing ships in operation, have been developed. The objective of these guidelines is to stimulate innovation and technical development to increase the energy efficiency of new designs, as well as energy efficient operation of ships in service by implementing a continuous cycle of improvement. Mandatory regulations, potentially on the basis of the current voluntary guidelines may be expected to be developed in the near future.

In this respect IMO’s key activity has been the development of the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP). Put in simple terms, the EEDI is calculating a reference value of CO₂ emissions at 75% of the propulsion power and “normal” auxiliary power distributed over the ship’s cargo carrying capacity (deadweight or gross tonnage) and ship speed (tonne CO₂ emitted per tonne mile transported). By creating benchmark values on the basis of the existing fleet (differentiating between type and size of ships) it would become possible to rate new designs and also to set new, stricter, design benchmarks for future designs. Power reduction may be considered for innovative mechanical energy efficient technology, as well as the effect of the carbon content of fuel. The EEDI applies to new ships on a voluntary basis. The objective is to stimulate innovation and technical development to increase the energy efficiency from the design stage.

The SEEMP is a voluntary ship environmental performance management tool providing an approach for monitoring and optimising efficiency performance of ship and fleet. Four key steps are to be considered:

- Planning;
- Implementation;
- Monitoring;
- Self-evaluation and improvement.

For the monitoring guidance is provided in terms of the Energy Efficiency Operational Indicator (EEOI). The EEOI for a given voyage is designated as the CO₂ emitted during a voyage (on the basis of fuel consumption) distributed over cargo mass (or TEU, passengers) and voyage distance (tonne CO₂ emitted per tonne mile transported). The EEOI objective is to stimulate energy efficient operation of ships in service by implementing a continuous cycle of improvement. The EEOI can be applied to new ships and existing ships, on a voluntary basis.

Apart from the viewpoint of emission regulations, ship owners may also have an incentive to reduce GHG emissions or, in other words, to increase energy efficiency. The key drivers are to reduce fuel expenses and exposure to volatile bunker fuel markets, to reduce CO₂ emissions and be prepared for (near) future regulations and the introduction of market based instruments (Emission Trading Scheme (ETS), bunker levy, etc.), to contribute to the reduction of the global carbon footprint of the entire supply chain and reduce reliance on fossil energy sources and/or to exhibit better energy performance than competitors (in particular if a rating system is established, e.g. vetting). Considering the latter point, going green could generate new business opportunities.

The above described developments are aiming at the energy performance of merchant ships transporting large quantities of cargo over comparatively long distances. As the operational profile of OSVs is very different from merchant ships it is questionable if the developed concepts can effectively be applied to these vessels. An anchor handling vessel, for example, does not carry any cargo, which theoretically results in infinite values for the EEDI and EEOI. Another issue is that OSVs are equipped with many power consumers for carrying out offshore operations (cranes, anchor handling equipment, DP systems, ROV controls, etc.) which require a relatively high installed power which is not used for propulsion or normal auxiliary purposes. How much of this power needs to be taken into account for the EEDI calculation is has not been considered. Moreover, as there are many different power configurations available it may become very difficult to achieve a common standard to compare the energy performance of different OSVs.

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3 For shipping CO₂ is by far the largest contributor to GHG emissions (more than 98%).
4 The Interim Guidelines for the calculation of the EEDI, MEPC.1/Circ.681, does not consider offshore support vessels.
Even though it can be demonstrated that the IMO instruments today cannot be realistically applied to OSVs, it is important for the industry to consider its environmental performance and to develop ways to improve it. This is particularly true for companies operating in ECAs (e.g. North Sea and Gulf of Mexico off the US coast) and in areas where there is strong national or regional focus on environmental protection and energy efficiency. One interesting development in this respect is the (recent) introduction of gas fuelled supply vessels in the North Sea basin. Application of engines running on Liquid Natural Gas (LNG) pose significant environmental benefits, as GHG reductions of more than 20% can be achieved. At the same time gas fuelled engines comply with the most stringent future NOx and SOx emission limits, as already highlighted in the previous sub-section. An additional advantage of gas propulsion is that it may prove to be a cost effective alternative from the viewpoint of operational expenditure (based on historical price development and expected future trends, as well as expected economy of scale effects due to increased demand). The main drawbacks are the fact that the required storage capacity of LNG is 2 to 3 times higher than for an equivalent amount of fuel oil and that today there is still a lack of availability of LNG at ports (lack of infrastructure due to historic lack of demand).

**Ballast Water Management Convention**

The Ballast Water Management (BWM) Convention was adopted on 16 February 2004, but has not yet been ratified by sufficient member states to enter into force. After MEPC 60 (March 2010) 22 countries representing about 22.7% of the gross tonnage of the world merchant shipping fleet have ratified the convention, while 30 countries, representing 35% of the world merchant shipping fleet are required. It is expected that the ratification will take place end 2010 or early 2011. The BWM Convention will enter into force 12 months after its ratification.

The convention will apply to all ships and contains requirements to carry out ballast water and sediment management on all voyages, as well as requirements for (approved) ballast water management plan and ballast water record book. In addition, Reg. D-2, regarding the ballast water performance standard (ballast water treatment), will enter into force in accordance with the timeline shown in Table 5.

<table>
<thead>
<tr>
<th>Keel Laying date</th>
<th>BW capacity (m³)</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2009</td>
<td>1500 – 5000</td>
<td></td>
<td></td>
<td>D1 or D2</td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2009</td>
<td>&lt;1500 or &gt;5000</td>
<td></td>
<td></td>
<td>D1 or D2</td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2009</td>
<td>&lt;5000</td>
<td>D1 or D2</td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2010</td>
<td>≤5000</td>
<td>D2</td>
<td></td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2009</td>
<td>&lt;25000</td>
<td></td>
<td></td>
<td>D1 or D2</td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2012</td>
<td>≥25000</td>
<td>D2</td>
<td></td>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D1: Ballast Water exchange standard  
D2: Ballast Water performance standard  

* Ships of less than 5000 m³ BW capacity constructed in 2009 (keel laying) are not required to be fitted with an approved ballast water treatment system until their second annual survey but not later than 31 December 2011.

The case of ships with less than 1500 m³ ballast water capacity, which is the case for most OSVs, is specifically considered. New ships for which the keel has been laid in 2009 will have to comply with the ballast water performance standard as soon as if the keel laying date is on or after 1 January 2012, while new ships for which the keel has been laid or will be laid in or after 2010 will have to comply as soon as the convention enters into force. Existing ships will have to comply with this standard on 1 January 2016.

Several ballast water treatment systems have already been given either basic approval or final approval by IMO (GESAMP). Systems having received final approval can apply for a formal type approval with a flag administration in order to obtain certification for actual installation on board.

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5 For ballast water treatment systems making use of active substances.
Operators of OSVs have raised concerns over the technical relevance of the Ballast Water Management Convention to the offshore industry, pointing out that OSVs are often engaged in coastal voyage (low risk of introducing unwanted aquatic organisms and pathogens), that the quantity of ballast water carried is limited and that the available space and weight for installing a ballast water treatment system onboard relatively small vessels is very limited. This issue is to be further addressed in cooperation between the industry and flag states in order to find agreement on a practicable solution.

With respect to the ballast water exchange standard, careful planning and management are required to control safety issues related to stability and longitudinal strength (in particular for sequential method, due to free surface moments and changing weight distribution), tank venting and tank structural strength (risk of over pressurising of tanks and ice accretion on deck (in particular for flow through method).

**Developments related to labour issues**

**Standards of Training, Certification & Watchkeeping**

During the 41st STCW Sub-Committee three developments specifically relating to OSVs were reported (STW 41/7/5, 28 September 2009). The scope is to amend Chapter V of the STCW Convention and Code as follows:

- Provide guidance regarding training and qualifications of masters and officers in charge of a navigational watch on board offshore supply vessels;
- Include recommendations for offshore supply vessels performing anchor handling operations, in particular with regard to:
  - navigation and position holding, ship handling, stability and operations in hazardous oil-field areas;
  - instruments and systems (load limiting devices and release systems of towing & anchor handling winches);
- Guidance on training and experience for personnel operating Dynamic Positioning (DP) systems, in particular considering DP control stations, operations & drills.

DP related training should not be limited to Dopes and DP masters only, but for example also include electrical engineers maintaining DP systems on board. Attention is paid to knowledge of type and purpose of documentation associated with DP operations (manuals, FMEA, capability plots, etc.).

It is acknowledged by both OSV operators and regulators that crew training is one of the key necessities for safe OSV operations. More and more companies operating OSVs are investing in training, while increased use is made of simulators specifically designed for offshore support vessel operations (e.g. DP operations and anchor handling).

**Maritime Labour Convention**

The Maritime Labour Convention (MLC) was adopted on 23 February 2006, but has not yet been ratified by sufficient member states to enter into force. The convention will enter into force 12 months after its ratification, which is expected end 2010 or early 2011. The MLC applies to all ships engaged in commercial activities, except fishing vessels, and to all seafarers working on these ships (certification is required for ships of 500 gt and over) and contains minimum requirements for almost all aspects of working conditions for seafarers. The set of rights and principles for seafarers aims to create a uniform standard and level playing field, which should provide the opportunity to attract more people to become seafarers. Some changes in ship arrangement design may be necessary to accommodate for the functional requirements of the convention, in particular in relation to accommodation, on-board recreational facilities and on-board medical care.

Some preliminary investigations by shipyards and owners show that the design related requirements of the MLC may be difficult to comply with for small vessels. This issue is also expected to impact small OSVs. Careful attention is to be paid to this topic in order to find practicable solutions which are acceptable to flag states.

**BV RULES FOR OFFSHORE SUPPORT VESSELS**

Following the previous section, in which the key international regulations and associated developments were presented, this section provides a brief overview of how these regulations are implemented into the
classification rules of Bureau Veritas (BV) by means of class notations and associated requirements. The objective is to show how the regulations can be comprehensively dealt with in class rules, providing ship owners, ship yards and designers with a practical and flexible regulatory framework.

**BV class notation and requirements for supply vessels**

Making use of Part A of BV Rules for the Classification of Steel Ships (NR 467, July 2010 edition) the basic class notation for a supply vessel can be described as follows:

- **I • HULL • MACH** (class symbol and construction marks)
- **supply vessel** (service notation)
- **unrestricted navigation** (navigation notation)

The class notation may be completed by several additional class notations.

Pt D, Ch 15 of the rules provides the specific class requirements applicable to all supply vessels. The hull and stability part considers the following items:

- General arrangement;
- Access arrangement;
- Side structure exposed to bumping (application of load distributing frames and stringers and efficient fendering);
- Protection and means of fastening for heavy cargoes and pipes on exposed deck;
- Specific areas of reinforced scantlings (deck plating and for side plating, ordinary stiffeners and load distributing stringers in bumping area, superstructure and deckhouse fronts, sides and aft ends, stern rollers and rudder stock (if any));
- Intact stability;
- Damage stability in case the additional class notation **SDS** (Subdivision and Damage Stability) is requested (follows the requirements of the OSV Design & Construction Guidelines, 2006).

The part on machinery and cargo systems covers:

- Piping systems not intended for cargo (pump, ballast lines, vent lines serving permanent ballast tanks to be independent from similar equipment serving cargo tanks);
- Piping systems serving spaces adjacent to cargo tanks and air/sounding pipes of gas-dangerous cofferdams;
- Cargo heating systems.

As a general note, BV Rules provide clear references to requirements from international regulations (MARPOL, IBC Code, IGC Code, etc.) by embedding those requirements in *italics* in the text.

The service notation **supply vessel** may be completed by one or more of the following additional service features:

- **oil product** for carriage of limited amounts of oil products with any flashpoint in bulk in cargo spaces;
- **LHNS** for carriage of limited amounts of hazardous and noxious liquid substances in bulk;
- **WS** for well stimulation vessels.

**Supply vessel - oil product**

The total capacity of cargo tanks designed to carry oil products having any flashpoint is to be less than 1,000 m³ and not to exceed 40% of the total underdeck volume of the ship (ref. MARPOL Annex I Reg. 2.2). An oil product is defined as petroleum, in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than petrochemicals which are subject to the provisions of MARPOL Annex II). The class requirements generally follow the OSV Design & Construction Guidelines, 2006, with additional requirements from MARPOL Annex I. A waiver for MARPOL Annex I requirements for slop tanks, oil discharge monitoring and control system and oil/water interface detector may be obtained. The control of discharge of oil is to be by retention of oil on board with subsequent discharge of all contaminated washings to (shore side) reception facilities.

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6 The class symbol I is assigned to ship built in accordance with the requirements of the Rules and maintained in a condition considered satisfactory by the Society. The construction marks HULL and MACH are assigned if the ship’s hull and appendices as well as the machinery installation is covered by classification.
The main requirements with regard to hull and stability cover:

- Compartment arrangement: cargo tank length not to exceed 10 m and to be in accordance with additional requirements depending on the general arrangement as shown in Table 6;
- Access arrangement (cargo area and gas-safe spaces);
- Intact stability (application of supply vessel criteria in accordance with IS Code, 2008 plus additional criteria for liquid transfer operations in accordance with MARPOL Annex I Reg. 27 in order to prevent lolling effects for ships of more than 5,000 dwt);
- Damage stability in case the additional class notation SDS is requested:
  - Deterministic approach with side damages in accordance with OSV Design & Construction Guidelines, 2006;
  - Additionally, deterministic approach with side and bottom damages in accordance with MARPOL Annex I Reg. 28: damage to be applied anywhere in ship’s length with exception of machinery space with damage extent shown in Table 7;
    - The final waterline is to be below lower edge of any opening through which progressive flooding may take place;
    - The angle of heel due to unsymmetrical flooding is not to exceed 25 degrees, or 30 degrees if no deck immersion occurs;
    - The range of righting lever to be at least 20 degrees beyond the equilibrium position, with a maximum residual righting lever of at least 0.1 m;
    - The area under the righting level curve is to be not less than 0.0175 m rad within this range;
    - Intermediate stages of flooding are to be investigated;
    - Equalisation arrangements requiring mechanical aids (valves, cross levelling pipes, etc.) may not be considered for reducing the angle of heel or attaining the minimum range of stability in order to meet the requirements.

Table 6: Maximum cargo tank length for supply vessel - oil product

<table>
<thead>
<tr>
<th>Longitudinal head</th>
<th>Type of cargo tank</th>
<th>b/L (1)</th>
<th>Centreline head</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No bulkhead</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(0.5 b/B + 0.1) L (2)</td>
</tr>
<tr>
<td>Centreline bulkhead</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(0.25 b/B + 0.15) L</td>
</tr>
<tr>
<td>Two or more bulkheads</td>
<td>Wing cargo tank</td>
<td>-</td>
<td>-</td>
<td>0.2 L</td>
</tr>
<tr>
<td>Centre cargo tank</td>
<td>if b/L &gt; 1/5</td>
<td>-</td>
<td>-</td>
<td>(0.5 b/B + 0.1) L</td>
</tr>
<tr>
<td></td>
<td>if b/L &lt; 1/5</td>
<td>No</td>
<td>Yes</td>
<td>(0.25 b/B + 0.15) L</td>
</tr>
</tbody>
</table>

(1) Where b is the minimum distance from the ship side to the outer longitudinal bulkhead of the tank in question measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.
(2) Not to exceed 0.2 L.

Table 7: Extent of damage for supply vessel - oil product (MARPOL Annex I Reg. 28)

<table>
<thead>
<tr>
<th>Damage</th>
<th>Longitudinal extent</th>
<th>Transverse extent</th>
<th>Vertical extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td>l_c = 1/3 L² or 14.5 m (1)</td>
<td>l_c = B/5 or 11.5 m (1)</td>
<td>v_c = without limit</td>
</tr>
<tr>
<td>Bottom</td>
<td>l_s = 1/3 L² or 14.5 m (1)</td>
<td>l_s = B/6 or 10.0 m (1)</td>
<td>v_s = B/15 or 6.0 m (1)</td>
</tr>
<tr>
<td>Any other part</td>
<td>l_s = 1/3 L² or 5.0 m (1)</td>
<td>l_s = B/6 or 5.0 m (1)</td>
<td>v_s = B/15 or 6.0 m (1)</td>
</tr>
</tbody>
</table>

(1) Whichever is the lesser

The key requirements of the part on machinery and cargo systems cover:

- Exhaust outlets from engines (to be as high as possible with spark arresters);
- Independent bilge system for spaces inside cargo area, without any connection with the bilge system serving gas-safe spaces of the ship (special consideration for non-toxic cargoes with flashpoint above 60°C);
- Cargo pumping, piping systems and pump rooms (incl. loading/unloading connections);
- Cargo tanks (design, construction, testing, level gauging/alarms, venting).

With regard to the electrical system the requirements applicable to the electrical installation of oil tankers are to be applied (system of supply, earth detection, mechanical ventilation of hazardous spaces, electrical installation precautions and hazardous locations and type of equipment).
The part on fire prevention, protection and extinction covers:

- External boundaries of superstructures and deckhouses enclosing accommodations, including supporting overhanging decks (insulation of A-60 standard for portions facing the cargo area up to 3 m away from the end boundary, or to be located at least 7 m away from the cargo area);
- Protection in accommodation and service spaces in accordance with method IC or equivalent;\(^7\)
- Ventilation, cargo tank gas-freeing and vapour detection;
- Deck area protection:
  - Deck foam system covering the entire deck area above the cargo tanks, with at least two portable foam applicator units;
  - Additional portable foam fire-extinguishing unit with portable foam tank for areas where cargo storage vessels are installed;
- Fire fighting in cargo pump rooms (two portable foam fire-extinguishers).

**Supply vessel - LHNS**

The aggregate quantity of designated bulk liquids to be less than 800 m\(^3\) and not to exceed a volume equal to 40% of the ship’s deadweight calculated at a cargo density of 1.0. Carriage of higher quantities of bulk liquids may be permitted if the survivability criteria of the IBC Code or IGC Code, as applicable, are complied with. A product list corresponding to the LHNS Guidelines is issued, containing:

- Hazardous and noxious liquids listed in the product list of Appendix 1 of the LHNS Guidelines (see Figure 4) and those products which may be assigned to the product list;
- Any flammable liquids.\(^8\)

The requirements generally follow the LHNS Guidelines. The hull and stability part covers:

- Compartment arrangement;
  - Cargo tanks containing designated products are to be located at least 760 mm measured inboard from the side of the vessel perpendicular to the centreline at the level of the summer waterline;
  - Accommodation/service spaces and control stations are to be located outside the cargo area;
  - Cargo tanks may extent up to the deck plating if no cargo is handled in that area; otherwise continuous permanent deck sheating (e.g. wood) is to be fitted;
  - Cargo segregation of cargoes which react in a hazardous manner with other cargoes or fuel oils;
  - Cargo segregation from machinery spaces, propeller shaft tunnels, dry cargo spaces, accommodation and service spaces and from drinking water and stores for human consumption (exemption for pollution hazard only substances with flashpoint exceeding 60 °C);
  - Tank openings and connections are to terminate above the weather deck and to be located in the top of the tank (except for connections to cargo pump rooms);
  - Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations are not to face the cargo area, unless located 7 m away from the cargo area (consideration for location of air intakes and openings in relation to cargo vent systems to guard against danger of hazardous vapours and exemption for pollution hazard only substances with flashpoint exceeding 60 °C);
  - Cargo pipes not to pass through any accommodation, service or machinery space other than (cargo) pump rooms (exemption for pollution hazard only substances with flashpoint exceeding 60 °C);
  - Cofferdam arrangements.
- Access arrangements;
- Intact stability (application of supply vessel criteria in accordance with IS Code, 2008);
- Damage stability in case the additional class notation SDS is requested (deterministic approach with side damages in accordance with OSV Design & Construction Guidelines, 2006);
- Acid spill protection (corrosion resistant coating & material for bulkheads and coamings up to 500 mm height and raised hatches (500 mm)).

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\(^7\) Method IC: construction of internal divisional bulkheads of non-combustible B or C class divisions generally without the installation of an automatic sprinkler, fire detection and fire alarm system in the accommodation and service spaces, except fixed fire detection and fire alarm to provide smoke detection in all corridors, stairways and escape routes within accommodation spaces.

\(^8\) Flammable liquid = any liquid with flashpoint not exceeding 60 °C.
The part on machinery and cargo systems covers:
- Exhaust outlets from engines (as high as possible with spark arresters);
- Independent bilge system for spaces inside cargo area, without any connection with the bilge system serving gas-safe spaces of the ship (special consideration for non-toxic cargoes with flashpoint above 60 °C);
- Separate cargo handling, pumping and piping system (not to pass though accommodation, service or machinery spaces except cargo pump rooms);
- Independent portable tanks on weather deck for cargo storage;
- Cargo pumping and piping systems (segregation (incl. transfer), acids);
- Cargo tanks (design, construction, testing, level gauging & alarms, venting);

With regard to the electrical system the requirements applicable to the electrical installation of chemical tankers are to be applied (system of supply, earth detection, mechanical ventilation of hazardous spaces, electrical installation precautions and hazardous locations and type of equipment).

The part on fire prevention, protection and extinction covers:
- External boundaries of superstructures and deckhouses enclosing accommodations, including supporting overhanging decks (insulation of A-60 standard for portions facing the cargo area up to 3 m away from the end boundary, or to be located at least 7 m away from the cargo area);
- Protection in accommodation and service spaces in accordance with method IC or equivalent;
- Ventilation, cargo tank purging/gas-freeing and vapour detection;
- Fire main/hoses;
- Deck area protection (fixed deck foam system or fixed fire-extinguishing system);
- Fixed fire extinguishing in cargo pump rooms where flammable liquids are handled (in accordance with IBC Code).

**Supply vessel - WS**

Well stimulation vessels are allowed to carry amounts of liquid substances higher than the maximum specified for the additional service feature LHNS. In order to do so, some additional requirements apply on top of the LHNS related requirements. In particular, more stringent damage stability requirements apply to well stimulation with the additional class notation SDS. Although the same deterministic approach (in accordance with the OSV Design & Construction Guidelines, 2006) is applied, for well stimulation vessels damage is to be considered to occur anywhere in the ship’s length at any transverse bulkhead (instead of between transverse bulkheads, as applicable to supply vessels carrying LHNS in bulk, see also the subsection LHNS Guidelines). An example of a modern supply vessel certified to carry oil products and LHNS and certified as well stimulation vessel is given in Figure 9.

Figure 9: DP2 supply vessel, well stimulation vessel & fire-fighting ship Punta Delgada was delivered to Naviera Bourbon Tamaulipas in 2009 (design: Guido Perla & Associates)
Other BV class notations relevant to offshore support vessels

This section describes the BV service notations, other than supply vessel, and additional class notations which have major relevance for offshore support vessels and their operations. A brief overview of the associated requirements will be presented as well.

BV rules for OSVs engaged in towing

The service notations relevant to OSVs engaged in towing, in particular AHTS vessels, are tug and salvage tug. Pt D, Ch 14 contains the specific requirements. The first point is intact stability for towing, which is related to the verification of the heeling moment due to the transversely acting towing force (resistance against girding). To this end, the area (A) contained between the righting lever and the heeling arm curves to be at least 0.011 m rad, measured from the heeling angle of static equilibrium $\theta_C$ to the heeling angle $\theta_D$, where $\theta_D$ is to be taken as the lowest of the following angles, see Figure 10:

- Angle $\theta_M$ corresponding to the position of $GZ_{\text{MAX}}$;
- Angle of downflooding;
- 40 degrees.

The heeling arm curve is to be calculated as follows (see also Figure 10):

$$b_H = \frac{T H c}{9.81 \Delta} \cos \theta$$

where T is the maximum (static) bollard pull, in kN, H the vertical distance between the towing point and half the draught corresponding to the displacement $\Delta$, in m, and c a coefficient taking into account the type of propulsion (c = 0.65 for non-azimuth propulsion, c = 1.00 for azimuth propulsion).

Figure 10: Intact stability criterion for towing

Other specific requirements include:

- Structural requirements for bollards, fenders, side plating and rudderstock;
- Anchors, chain cables and ropes;
- Towing arrangements (hooks and winches, quick-release devices (winch, hook) and supporting structures);
- Salvage equipment.

In this respect it is important to note the ongoing development of harmonised guidelines for the design and operation of tugs by classification societies Bureau Veritas, Lloyd’s Register of Shipping and American Bureau of Shipping, which is carried out within the scope of SafeTug II Joint Industry Project, as described in Part II of this paper.

In addition, it is to be noted that BV is working on the introduction of a new service notation anchor handling vessel, which will contain specific requirements for ships engaged in anchor handling operations, in particular with respect to stability requirements and winch performance requirements (e.g. emergency quick-release), see also the sub-section Anchor Handling Guidelines.
**BV rules for OSVs engaged in fire-fighting**

The service notations relevant to OSVs engaged in fire-fighting, in particular PSVs, AHTS vessels and stand-by rescue vessels, are as follows:

- fire-fighting ship 1
- fire-fighting ship 2
- fire-fighting ship 3
- fire-fighting ship E (special category)

as well as the additional service feature water spraying for self protection. The specific requirements are given in Pt D, Ch 16, and include intact stability, fire fighting systems and fire protection systems.

With regard to intact stability it is to be verified that the heeling angle of static equilibrium as a consequence of the heeling moment caused by jet water from monitors acting in the transverse direction is less than 5 degrees, see Figure 11.

![Figure 11: Intact stability criterion for fire-fighting](image)

Requirements for machinery systems design cover alarms to prevent engine overload and minimum fuel oil capacity (24 h for fifi class 1; 96 h for fifi class 2 & 3).

The key points addressed with regard to the fire-fighting system are the following:

- Independence of pumping and piping systems (supply of water and foam monitors, water-spraying system and portable fire-fighting equipment);
- Design and construction of piping systems;
- Monitor and monitor control requirements;
- Water fire-fighting systems (number of pumps, monitors and characteristics as function of fifi class);
- Fixed-foam fire-fighting systems;
- Portable fire-fighting equipment (number of hydrants and fire hoses as function of fifi class);
- Firemen’s outfits;
- Testing.

For fire protection the following applies:

- For service notation fire-fighting ship 1 all exterior boundaries above lightest operating waterline, including superstructures and exposed decks to be of steel and to be internally insulated by A-60 class divisions, unless the additional service feature water spraying is assigned;
- For service notations fire fighting ship 2 and fire fighting ship 3 all exterior boundaries are to be of steel (no insulation requirements).
For the self-protection water-spraying system, in general, a minimum capacity of 10 l/min for each square metre of protected area is required. In case of insulation by A-60 class divisions the minimum capacity is 5 l/min. All vertical areas of hull and superstructures, monitor foundations and of the fire-fighting arrangements need to be protected.

**BV rules for OSVs engaged in oil recovery**

The service notation assigned to OSVs engaged in oil recovery, in particular PSVs, AHTS vessels and stand-by rescue vessels, is oil recovery ship. Pt D, Ch 17 contains the specific requirements. The key points are as follows:

- Segregation of spaces intended for retention of oil (cofferdams, tanks);
- Definition of dangerous spaces (accumulation tanks, surrounding spaces, pump rooms, spaces with piping, deck areas, etc.);
- Access to safe spaces (accommodation and service spaces);
- Power pumps or bilge ejector to drain recovered oil pump room;
- Routing of exhaust gas systems in relation to dangerous zones;
- Design of pumping/piping system and pump rooms for recovered oil (no piping through accommodation spaces, machinery spaces, service spaces and other enclosed gas-safe spaces);
- Settling & accumulation tanks (vent pipes, level gauging & overfilling control, heating);
- Design requirements for electrical systems:
  - Supply and earth detection;
  - Electrical equipment permitted in hazardous areas: certified safe type in relation to the designated hazardous area (Zone 0, 1 or 2);
- Fire protection, detection and extinction:
  - Ventilation systems (recovered oil pump rooms, other enclosed normally entered dangerous spaces, enclosed safe spaces adjacent to dangerous areas);
  - Oil flashpoint and gas measurement systems for operation at safe distance from oil spill source
  - Exterior boundaries of superstructures and deckhouses enclosing accommodation (including overhanging decks) are to be insulated to A-60c class standard for portions facing gas-dangerous areas up to 3 m away from the boundary;
  - Two dry powder fir extinguishers are to be installed;
  - At least one portable foam extinguishing installation is to be fitted.

An example of a modern AHTS vessel certified for towage, fire fighting and oil recovery activities is given in Figure 12.

Figure 12: DP2 AHTS vessel, fire-fighting ship & oil recovery ship Brodospas Alfa was delivered to Brodospas in 2009 by the Damen Galati shipyard
BV rules for OSVs stand-by rescue vessels

The service notation assigned to OSVs working as stand-by rescue vessel is **special service - standby rescue vessel**, which is usually completed by the number of survivors the vessel is designed for and the operating area, for example: **special service - standby rescue vessel (150 survivors, Guinea Gulf)**. The requirements are provided in BV Rule Note NR482 Standby Rescue Vessels. An example of a specialised stand-by rescue vessel is given in Figure 13.

Specific requirements include the following:
- Minimum speed of 10 kn for vessels of more than 35 m in length;
- Single screw propulsion and 360° azimuth thruster unit (with thruster unit independent from the main engine and capable of ahead speed of 4 kn) or twin screw propulsion and side thruster such that the vessel is capable of ahead speed of 4 kn with one main propulsion out of action;
- Exhaust pipes with spark arresters;
- Rescue equipment and facilities
  - Rescue zone of minimum 8 m length on both sides, clearly marked (away from propellers or thrusters and clear from ship discharges up to 2 m below the summer waterline);
  - Minimum necessity for vertical transfer;
- Functional requirements rescue zone with regard to general arrangement (free of obstructions, no fenders), deck area (free deck area, protection against injury in case of necessary deck obstructions), lighting, bulwarks and guardrails, search light, whistle/bell, scrambling net and fresh water supply for survivors (0.85 t of fresh water and 0.7 t of potable water per group of 50 survivors);
- For survivor spaces dedicated sheltered accommodation (lighting, ventilation, heating) is required, as well as means of escape and sanitary facilities;
- Safety equipment:
  - At least 1 SOLAS approved fast rescue boat for standby duties;
  - SOLAS requirements for vessels of 500 gt and over;
  - For vessels of less than 500 gt: 1 line throwing appliance (not less than 4 projectiles and 4 lines), 1 daylight signalling lamp, 6 lifebuoys (4 with self-igniting electric light and buoyant line), 1 SOLAS type approved immersion suit for each crew member, 1 SOLAS type approved lifejacket for each crew members plus 25% of the number of survivors);
- Provision of personal care and medical provisions (blankets, towels, disposable coveralls, etc.).

Figure 13: Stand-by rescue vessel *Esvagt Corona* was delivered to Esvagt in 2004 by Astilleros Zamakona

BV rules for additional class notations relevant to OSVs

Many OSVs, in particular modern IMR and diving support vessels, are equipped with sophisticated offshore cranes, for which BV rules provides the following family of additional class notations:
- **ALP** (lifting in harbour: loading/unloading cargoes, equipment, etc.)
- **ALM** (lifting in offshore conditions)
- **ALS** (lifting at sea for launching and recovering diving devices, diving support)
The requirements are provided in BV Rule Note NR 526 Rules for the Classification and the Certification of Cranes onboard Ships and Offshore Units and cover certification, issuance of Bureau Veritas Cargo Gear Register, certification on behalf of national authorities, certification in compliance with special national rules, as well as other interventions.

Another important family of additional class notations applicable to many types of OSVs is DYNAPOS, which covers certification of Dynamic Positioning systems. The following optional additional symbols can be assigned:

- **SAM** (Semi Automatic Mode; manual intervention)
- **AM** (Automatic Mode; automatic position keeping)
- **AT** (Automatic Tracking (unit is maintained along a predetermined path, at a preset speed and with a preset heading which can be different from the course))
- **R** (Redundancy implies equipment class 2 in accordance with IMO Circ. 645)
- **RS** (Redundancy is achieved by two systems or alternative means of performing a function physically separated; equipment class 3 in accordance with IMO Circ. 645)

Typical notations for OSVs are DYNAPOS AM/AT (equivalent to DP1), DYNAPOS AM/AT R (equivalent to DP2) and DYNAPOS AM/AT RS (equivalent to DP3). The requirements are provided in Pt F, Ch 10, Sec 6 of Bureau Veritas Rules for the Classification of Steel Ships (NR 467).

In addition to the above described operations related additional class notations also the additional class notations relating to environmental protection are becoming more and more important for OSVs, in particular when they operate close to densely populated coastal areas or in environmentally sensitive areas. With regard to pollution prevention the additional class notations CLEANSIPH (C), CLEANSHIP and CLEANSHIP SUPER are available in BV rules. Each notation can be completed by the additional symbol AWT if an Advanced Wastewater Treatment installation is installed, as well as an additional number to specify the number of consecutive days the ship is able to operate with the full complement of on-board personnel, including crew and passengers, without the need for discharging any substances into the sea (minimum is 1, 7+ when more than 7 days). An example of a class notation for pollution prevention for an OSV could be CLEANSHIP 5. Specific requirements are given in Pt E, Ch 9 of Bureau Veritas Rules for the Classification of Steel Ships (NR 467) and include a bilge separator and alarm, a type approved sewage system, a type approved incinerator and, for the additional class notation CLEANSHIP SUPER, compliance with the Ballast Water Management Convention. The additional class notation CLEANSHIP (C) does not contain a sulphur limit in the bunkering requirements (intended for ships operating in areas with limited or no availability of low sulphur fuel). Another available additional class notation relating to pollution prevention is PROTECTED FO TANK, which covers compliance with the oil fuel tank protection requirements of MARPOL Annex I Reg. 12A. The requirements are provided in Pt E, Ch 10, Sec 13 of Bureau Veritas Rules for the Classification of Steel Ships (NR 467). BV has also issued guidelines to assist ship owners and yards in complying with future environmental regulations, for example the Guidelines on the Ballast Water Management Convention (NI 538).

As described before gas propulsion and fuel cells may prove to be an interesting and cost-effective solution to the environmental challenges faced by the shipping industry. In order to assist shipyards and shipowners in the development of novel propulsion concepts (e.g. hybrid power systems) BV has developed several rules and guidelines based on research & development work as well as in-service experience (in particular with gas carriers). The following rules and guidelines are available:

- Safety Rules for Gas-Fuelled Engine Installations in Ships (NR 529);

**HARMONISED SAFETY GUIDELINES FOR TUGS**

As previously described in Part I, offshore support vessels are regularly engaged in towing activities. In order to do so they are certified as tugs by classification societies. A comparison between the rules for tugs of different societies shows that there are considerable differences in requirements. The same can be said of the statutory requirements of flag states, in particular for non-Convention vessels (tugs of less than 500 gt). This provides challenges for owners, builders and designers of OSVs and tugs, in particular because it is quite common in the industry to develop standardised designs. In addition, today’s tug rules are not always up to date with regard to the latest technical developments of the industry, which creates difficulties for the certification of advanced equipment and systems.
In response to these challenges faced by the industry, leading class societies Bureau Veritas, Lloyd’s Register and American Bureau of Shipping have launched a joint effort to develop safety guidelines for design and construction of tugs, which focus on key issues such as towing and escort stability, towing equipment, safety equipment and also addresses issues related to the assisted ship and safety management on tugs. A revised set of class notations and requirements is proposed with the goal of creating a comprehensive regulatory framework in support of the tug industry. The project is carried out under the umbrella of the SafeTug II JIP, which enables incorporation of the latest results of relevant R&D work, as well as receiving active experience feedback tug operators, designers, builders and equipment manufacturers.

In May 2010 the draft version of the Safety Guidelines for Design, Construction & Operation of Tugs was presented at the International Tug & Salvage Convention & Exhibition in Vancouver. For a detailed description of the project description of the project, including the technical background, reference is made to the conference paper The Class Answer to the Rapidly Developing Tug Industry [1]. In this section the key points will be presented, with a focus on the relevance for offshore support vessels engaged in towing.

**Regulatory framework**

The following set of service notations and additional service features is proposed:

- **harbour tug (bollard pull = T kN)**
  - (operating within port limits)
- **tug (bollard pull = T kN)**
  - optional additional service feature: **sailing time ≤ 4 h from safe sheltered anchorage**
- **escort tug (maximum steering force = TY kN at speed VY kn, maximum braking force = TX kN at speed = VX kn)**
  - optional additional service feature: **sailing time ≤ 4 h from safe sheltered anchorage**

The additional service feature **sailing time ≤ 4 h from safe sheltered anchorage** relates to crew familiarity with the area of operation and the required level of autonomy of the ship (tugs operating in coastal area do not need to be as autonomous as vessels operating engaged in unrestricted trans-ocean towage). This feature is considered particularly useful for harbour tugs also engaged in ship assist at sea (port approach, anchorage, straits, estuaries, etc.) and (escort) tugs engaged in coastal towage or offshore terminal operations. In both cases the crew familiar with operating area and shore side facilities & emergency assistance are readily available.

As the majority of the OSVs are operating worldwide without any restriction and are not engaged in escort towage (emergency steering, braking and otherwise controlling of ships and offshore units during navigation, typically sailing at a speed in excess of 6 kn), the main focus will be on the service notation tug without additional service feature. In some cases (OSVs operating at a specific location) other service notations could be considered.

**Harmonised requirements**

Within the context of the harmonisation project the following specific requirements have been developed. An important step is the introduction of a new rationalised towing intact stability criterion for tugs, which has been developed on the basis of an analysis of the existing regulations as well as theoretical considerations. The new criterion requires that the area (A) contained between the righting lever and heeling arm curves, measured from the first intersection (angle of static equilibrium) and the second intersection or the angle of downflooding, whichever occurs first, is to be larger than the area (B) contained between the heeling arm and righting lever curves, measured from a heeling angle of zero to the first intersection, see Figure 14. In fact, the criterion requires that the available righting energy is greater than the maximum heeling energy.

The heeling arm curve is calculated as follows:

\[
b_h = \frac{7Hc}{9.81\Delta} \cos \theta
\]

where \( T \) is the maximum (static) bollard pull, in kN, \( H \) the vertical distance, in m, from the towing point (staple, hook or equivalent fitting) to the centreline of the propeller(s), \( \Delta \) the displacement, in tonnes, and \( \theta \) the angle of downflooding.
Coefficient taking into account the type of propulsion (c = 0.50 for ships with non-azimuth propulsion such as conventional tugs), c = 0.70 for ships with azimuth propulsion such as tractor and ASD tugs), see Figure 15.

**Figure 14: New proposal for intact stability criterion for towing**

**Figure 15: Definition of parameter H (vertical distance from towing point to centreline of propellers)**

Special attention has been paid to the conditions for accepting a lesser height of machinery space ventilator coamings on tugs to satisfy the ILLC requirements for continuous and adequate air supply of ventilation and the fitting of closing appliances on ventilators with coamings less than 4.5 m above deck, which is typically the case for smaller tugs.

In this way a theoretically consistent towing stability criteria representing the self-tripping (or tug induced tripping) mechanism has been created, for which the results are in line with the more onerous existing towing stability requirements (class, flag state), which are generally applied and accepted by industry. Validation calculations performed for five modern tug designs (2 conventional tugs (twin propellers) & 3 ASD tugs), all show compliance with the new criterion. It is to be noted that same theoretical considerations could be used to drafting a residual area criterion for anchor handling stability as referred to in the sub-section Anchor Handling Guidelines.

Special attention for the assessment of escort tugs, which are considered as a special category due to the nature of their operations. An additional escort stability criterion requiring positive freeboard (no deck immersion) has been introduced. In addition criteria for accepting computer simulations as alternative to full scale testing for the evaluation of the steering and braking forces are under development (validation issue under consideration).

Recognising that keeping the connection between the tug and the towed vessel is of key importance (safety of the combined system of tug and assisted ship is to be considered), the towing equipment has been brought explicitly within the scope of classification. Particular attention is paid to the design loads to be considered (taking into account line dynamics), on the basis of which requirements have been drafted for towing winches and hooks, towing fittings, as well as pushing areas and fenders.
The applicable towing equipment requirements include fitting of a reliable emergency quick-release arrangements for towing winches and hooks facilitating towline release for all operational modes, regardless of direction of towline and angle of heel of tug, which are to be operable locally (at winch or hook) and from bridge with full view and control of operation. The time delay between starting emergency release sequence (by the operator) and de facto paying out of towing winch to be as short as practicable, the speed of the emergency paying out is to be suitable for intended operation and the system should be operable independently of winch power supply. Applicable procedures for quick-release systems, including time delays and release speed, are to be communicated to ship's crew. Vital information is to be displayed next to control desk, which is similar to the proposed requirements for anchor handling vessels. After emergency release winch brakes should revert to normal function without delay.

The harmonised safety equipment requirements have been drafted on the basis of IACS Rec. 99 Recommendations for the Safety of Cargo Vessels of less than Convention Size (December 2007), the MCA Small Workboat Code and experience feedback, which can be proposed to flag states for statutory acceptance. Requirements are a function of the service notation and additional service feature selected by owner and shipyard/designer. In this way the requirements can be made fit for purpose for the intended operation of the tug (e.g. harbour towage, offshore terminal assistance or deep sea towage). The requirements with regard to fire safety (fire protection, fire detection and fire-fighting), life saving appliances, radio installations and navigation equipment are presented by means of the easy-to-use Safety Matrix, see Table 7 for an example. In addition requirements for anchoring equipment are provided, again taking into account the operational profile of the tug. In addition, reduced anchor equipment is considered acceptable on the basis of redundancy of the propulsion systems and the installation of a fixed fire-fighting installation.

Table 7: Example of harmonised Safety Matrix for fire safety

<table>
<thead>
<tr>
<th>service notation</th>
<th>tug, escort tug</th>
<th>tug, escort tug</th>
<th>harbour tug</th>
</tr>
</thead>
<tbody>
<tr>
<td>additional service feature</td>
<td>&gt; 4 h from port or safe sheltered area</td>
<td>≤ 4 h from port or safe sheltered area</td>
<td>(in port)</td>
</tr>
<tr>
<td>≥ 150 gt</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>independently driven power pumps</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>≤ 150 gt</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>hand pumps</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>≤ 150 gt</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>independently driven power pumps</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>power pumps</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>hand pumps</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>portable or fixed emergency fire pump</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

The assisted ship is to be explicitly considered, in particular the strength of bollards and tug pushing points, in order to ensure that the forces exerted by the tug can actually be absorbed by the assisted vessel. Feedback from the European Tugowners Association (ETA) and the European Maritime Pilots Association (EMPA) learns that problems do exist and that further consideration is required, see [4]. Regardless from the technical aspect, effective communication between the tug and assisted vessel is a precondition for successful tug assistance. To this end the importance of proper education and training is emphasised.

In addition, guidance for the voluntary implementation of the International Safety Management (ISM) Code for tugs of less than 500 gt is provided, which aims at improving safety of both operations (safety on board during mobilising, towage, etc.) and management. Again much attention is paid to the interaction with assisted ship.

CLOSURE

Analysis of the current OSV market shows that the fleet is rapidly growing (both in numbers, but in particular in tonnage) and that offshore support vessels are becoming ever more sophisticated. A fleet of highly advanced multi-functional vessels (e.g. deep water IMR vessels and high bollard pull dynamically positioned anchor handling tug supply vessels with oil recovery and fire-fighting capability) is under construction. There is also a clear drive to design and build OSVs for operations in ice invested waters (for supporting the oil & gas activity), including ice breaking and ice management. Another important development is the increasing focus on energy efficiency and reduction of the environmental footprint, which has resulted in more energy efficient designs and the introduction of LNG powered OSVs with promising environmental and economical
performance. Safety of OSV operations remains one of the key drivers of the industry, with is putting great emphasis on anchor handling vessels, the carriage of (newly developed) complex hazardous noxious liquid substances in bulk supply vessels and will, without doubt, also focus on the lessons which can be learnt from the tragic accident with the Deepwater Horizon in the Gulf of Mexico. In addition to technology it is clear that care is to be taken with regard to crew training and familiarisation.

International regulations and guidelines for OSVs have been adapted to incorporate the latest developments of the SOLAS and MARPOL Conventions, which are having an impact on the design of OSVs. The main developments have been in the Guidelines for Design and Construction of OSVs, the LHNS Guidelines and the SPS Code, while work is ongoing in relation to the development of international requirements for anchor handling vessels and amending the STCW Convention and Code to explicitly consider anchor handling and dynamic positioning operations. With regard to environmental protection, the revised MARPOL Annex VI and NOx Technical Code, as well as the Ballast Water Management Convention will drive further changes in design and operation, also for OSVs. Finally, the industry will be confronted with the introduction of the Maritime Labour Convention, which will introduce a set of rights and principles for seafarers and aims to create a uniform standard and level playing field.

It is important to consider that the implementation of some of the international standards, for example the Ballast Water Management Convention and the Maritime Labour Convention will cause issues for the OSV industry, in particular for smaller vessels with limited available space and weight. Timely and coordinated industry action is required to resolve these issues, in particular considering that the agreement of flag states may be required.

Although no international regulations have yet been developed with regard to the emission of greenhouse gasses it is important for the maritime industry to anticipate and to be pro-active in further developing energy efficient designs by making use of both existing and newly developed technologies.

Bureau Veritas has developed specific class rules for OSVs, taking into account international regulations as well as experience feedback from actual design and operation. A wide variety of relevant class notations and associated requirements is available to ship owners, yards and designers in order to obtain classification in agreement with the ship specification. In this respect Bureau Veritas is at the forefront with regard to the classification of the new generation of highly sophisticated OSV designs, which incorporate the latest safety standards while standing out in operational performance.

As many offshore support vessels are engaged in towing operations it is important to note that a harmonisation project for safety related class rules for tugs is being carried within the scope of SafeTug II JIP. Due to direct engagement of tug owners/operators, designers/shipyards, research institutes and equipment manufacturers it is possible to incorporate all available knowledge and experience. A draft document for harmonised guidelines for the design and construction of tugs, including escort tugs has been issued, considering the regulatory framework (including service notations), design loads, towing and escort stability, towing equipment and safety equipment. In addition, the link with the assisted ship is made explicit and guidance for the voluntary implementation for the ISM Code for tugs of less than 500 gt is provided. The guidelines will be finalised following feedback from SafeTug II participants. It is expected that the document will provide useful guidance for the design and operation of OSVs engaged in towing.

REFERENCES