

IMO REGULATIONS ON NO_x AND SO_x AND ITS EFFECTS ON YACHTDESIGN

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SUMMARY

The International Maritime Organization (IMO) is an agency of the United Nations, formed to promote maritime safety and environmental protection. This paper is to summarize IMO conventions due entry into force and that are likely to affect the yacht industry. Main focus will be given to emission limits of nitrogen oxides (NO_x) set in the 'International Convention for the Prevention of Pollution from Ships' (MARPOL), Annex VI. The implementation of catalyst technology on large yachts appears currently to be the only viable technology to meet these limits with likely high impact on certain sections of the large yacht industry.

1. INTRODUCTION

Annex I provides a list of pending legislation in IMO which is likely to affect the large yacht industry. Highlighted should be the requirement starting 01 January 2013 for Ship Energy Efficiency Management Plan or SEEMP for ships above 400 GT. This plan, which is ship-specific, will set out best practices for the fuel efficient operation of a vessel. Although ship operators are responsible to produce SEEMP, it is expected yards will be requested to assist in producing it. Guidelines from IMO are set in MEPC.1/Circ.683.

Also listed in Annex I are IMO's emission standards which have been adopted in 2008 and entered into force in 2010. Tier III implementation starts 01 January 2016 and is expected to be a rule that requires catalytic aftertreatment of exhaust gasses. Below is a description of the technical challenges expected from Tier III and reflects the current knowledge of the international recreational marine association and its members. This understanding is based on today's knowledge but technical developments until 2016 deadline could reduce the expected impact of the rule. The strong message from system and engine manufacturers is that this technology is developing at a rapid pace and the products available in 2016 may well bear little resemblance to those available today. Catalyst developers need to understand in more detail the specific restrictions that yacht arrangements cause. There is potentially considerable flexibility in the design of these systems and there may be options to change catalyst shape, size, lengths etc. but there are many variables that influence this design.

2. MARPOL ANNEX VI EMISSION LIMITS

IMO's International Convention for the Prevention of Pollution from Ships (*MARPOL*) introduced amendments in 2008 which reduce the permitted SO_x and NO_x emissions from ships' engines. The main changes to MARPOL Annex VI are a *global* progressive reduction in emissions of Sulphur Oxides (SO_x) Particulate Matter (PM) and Nitrogen Oxides (NO_x) and the implementation of more stringent *local* limits in Emission Control Areas (ECAs).

2.1 Sulphur limits

SO_x emissions reductions will mainly be met by changes in fuel. Modern yacht engines are already required to operate on high-quality, low-sulphur diesel and it is expected these changes will mostly affect general shipping which today relies on the use of heavy fuel oils and will be forced to use distillate fuels (diesel) in ECAs. Hence, IMO SO_x emission limits are not expected to impact yachts technically or in their operation, although there could be an increase in pricing due to higher demands.

2.2 NO_x limits

The new Annex VI Regulations set NO_x limits as follows in Tiers II and III for engine types commonly used in yachts (high speed diesel):

| Tier | Date | NO _x Limit, g/kWh |
|---|-----------------|------------------------------|
| Tier II | 1 January 2011 | 7.7 |
| Tier III | 1 January 2016* | 1.96 |
| * In NO _x Emission Control Areas (Tier II standards apply elsewhere) | | |

IMO emission regulations apply to all engines over 130 kW except emergency generators, lifeboat engines, recreational vessels less than 24m length and vessels less than 750 kW total propulsion power if design and construction limitations preclude compliance.

There is presently only one NOx Emission Control Area which covers the USA, Canada and US Caribbean territories. However the imposition of others is being discussed. All vessels entering an ECA must conform to IMO Tier III (US flagged vessels are separately regulated by US EPA limits Tier 3 and 4 and must not be confused with IMO Tier III).

Implications of NOx ECAs are that yacht designs must meet Tier III unless guaranteed will never sail into these ECAs. The latter scenario is unlikely to occur on large yachts.

3. TIER III COMPLIANCE

Three years until the rule enters into force and two years into ICOMIA's research, it is difficult to obtain a full overview what technologies will be available from engine and system manufacturers to meet Tier III. From today's perspective it appears most likely engines will require engine exhaust after treatment through use of Selective Catalytic Reduction (SCR) catalysts since it is currently the only viable technology suitable for demands of marine use. Although in-engine solutions such (e.g. Exhaust Gas Recirculation, Miller Cycle ...) are being considered and will probably find use on low and medium speed engines, there are currently little or no indications of implementation in the large yacht sector.

Unlike aftertreatment systems known from e.g. on-road applications (3-way and oxidation catalysts), SCR need Ammonia (NH₃) as additional substance/agent for the catalytic conversion to take place. In the conversion process, NH₃ is atomized in the engine exhaust stream and converts NO_x + NH₃ to N₂ + H₂O, i.e. Nitrogen and Water which are substances of no environmental concern. Since Ammonia could raise significant safety and comfort issues when handled incorrectly, it is diluted into harmless urea solution, often traded under the name AdBlue, or technically referred to as Diesel Emission Fluid (DEF).

While there is broad agreement the technology to meet Tier III is in theory available, many who are looking into technical solutions to meet Tier III expect significant impact on the yacht industry since SCR will demand additional space. Where many existing engine room layouts already seem to be over-equipped, SCR adds a bulky and heavy set of additional components to the engine system; a substantial increase in machinery space for new builds looks inevitable. SCR needs to be mounted in the immediate vicinity of the exhaust manifold of the propulsion engine since it is only operational above exhaust gas temperatures of approx. 280C. Below these temperatures the catalyst substrate can be irreversibly damaged, therefore no system will inject urea; exhaust gas conversion is effectively deactivated. Moving the SCR away from the engine to a more convenient location is near prohibitive – exhaust gases would cool below SCR operational temperatures or require re-heating. SCR size is currently a variable since it is closely linked to the percentage of sulphur in fuels used. Worst-case scenarios expect it to be in the range of 50 – 30% of the engine size and weight. In relative terms, catalyst size starts to increase when sulphur levels in fuel exceed 1000 – 500 ppm (0.1 – 0.05%). Initial studies confirm global availability of low sulphur fuels which are below this critical mark. Hence it seems likely the industry will require operators to bunker fuels that contain less than 1000 – 500 ppm sulphur in order to keep catalyst size at a very minimum.

On all ships, in addition to the fitting of SCR, functionality for the operation of SCR includes accessibility and maintainability of all components. Next to the reactor casing, these are urea tanks, control units for the operation of the system and a large mixing pipe between exhaust manifold and SCR. Some systems require compressed air for the injection of urea which would also need to be accommodated.

4. CONCLUSIONS

To identify possible issues raised by Tier III, it is crucial for the industry to have an in-depth understanding of its possible impact. However, SCR technology evolves rapidly and commercial businesses are concerned at disclosing sensitive data. Being an industry association with little direct insight in the daily routine of engine manufacturers and yards and their mutual communication, ICOMIA addresses Tier III by raising industry awareness, facilitating the discussion amongst stakeholders and obtaining evidence of the impact of the rule. This is key to flagging up possible compliance issues with the regulating body IMO where ICOMIA has consultative status. Certainly IMO has recognized Yachts as field where physical constraints exist that may limit the application of technologies. These need to be considered further and whether those constraints may be solved.

ANNEX I – SUMMARY OF LEGISLATION PENDING AT IMO

The following table provides a summary of the principal legislation originating from IMO that will have or will likely have an impact on the yachting industry.

The table lists the title of the regulation, the IMO Committee and/or Sub-Committee that is responsible for it, a brief description and assessment of the likely impact on the industry, details on the pros and cons on each of the rules and the entry into force date.

Order of appearance:

- Manila Amendments to STCW
- Intact Stability Code 2008 – Second Generation Stability Criteria
- Ballast Water Management Convention – Biofouling Management Plan
- Shipboard Oily Waste Pollution Prevention Plan
- Integrated Bilge Water Treatment Systems (IBTS)
- Polar Code
- Recovery Capability
- Code on Noise Levels Onboard Ships
- EEDI and SEEMP
- Market-Based Measures – MBM's
- Garbage
- BA sets – low pressure warning alarm
- Means of recharging air bottles for BA sets and communication equipment for fire-fighting teams
- Means of escape from machinery spaces

The abbreviations for the various IMO Committees used in the table are as follows:

BLG: Sub-Committee on Bulk Liquids and Gases
DE: Sub-Committee on Ship Design and Equipment
FP: Sub-Committee on Fire Protection
MEPC: Marine Environment Protection Committee
MSC: Maritime Safety Committee
SLF: Sub-Committee on Stability and Load Lines and on Fishing Vessel Safety
STW: Sub-Committee on Standards of Training and Watchkeeping

The order of the table is the order in which the meetings were held recently and does not reflect the significance of the legislation.

| Legislation | Sub-Committee | Committee | Description and likely impact | Pros and Cons | Entry into force |
|---|---------------|-----------|--|---|--|
| Intact Stability Code 2008 – Second Generation Stability Criteria | SLF | MSC | <p>Additional stability criteria are being introduced into the updated code as follows:</p> <ul style="list-style-type: none"> • Pure loss of stability due to reduced righting levers • Parametric rolling • Dead ship conditions • Surf-riding/broaching • Excessive accelerations resulting from “excessive stability” <p>Certain yacht designs may not fully comply with these additional criteria.</p> | <p><u>Pros</u></p> <p>a) Enhanced stability and safety standards.</p> <p><u>Cons</u></p> <p>a) Possible adverse effect on existing yacht designs.</p> <p>b) Possible additional building costs to meet new standards.</p> | Est. 2014 with transitional phase-in periods dependent upon vessel type. |
| Ballast Water Management Convention - Biofouling management plan | BLG | MSC-MEPC | All vessels (including recreational craft over 24m) will be required to have a Biofouling Management Plan and to keep records in a Biofouling Record Book. | <p><u>Pros</u></p> <p>a) Environmentally friendly.</p> <p>b) Possible revenue earner for management companies.</p> <p>c) Easy to implement using comprehensive IMO guidelines.</p> <p><u>Cons</u></p> <p>a) More paperwork and administration adding to already overworked crew in many cases</p> | On entry into force of BWM 2004 Convention. This will be 12 months after ratification by 30 states representing 35% of world merchant shipping tonnage. As of 30/11/11 the convention had been ratified by 31 states representing 26.44% of world tonnage. |
| Shipboard Oily Waste Pollution Prevention Plan | DE | MSC | This consists of documented procedures to ensure proper oily waste disposal in accordance with relevant flag and port state regulations. IMO guidelines on | <p><u>Pros</u></p> <p>a) Easy to produce and implement.</p> | No plans to make this mandatory at present. |

| Legislation | Sub-Committee | Committee | Description and likely impact | Pros and Cons | Entry into force |
|---|---------------|-----------|---|--|--|
| | | | the format and content of the plan would make implementation simple for yachts. | <u>Cons</u> a) Additional administrative burden with little benefit to yacht operations | |
| Integrated Bilge Water Treatment Systems (IBTS) | DE | MSC/MEPC | <p>The concept of this system is to prevent water and waste oil mixing in the bilges by providing separate drains for waste water and oil. This means that there is no need to find ever more improvements to the efficiency of oily water separators.</p> <p>At present there is no requirement to make IBTS mandatory although IMO is actively encouraging its adoption. Should it become mandatory there would likely be minor cost and space issues for the yachting industry.</p> | <u>Pros</u> a) Cleaner more efficient means of collecting and disposing of waste oil. <u>Cons</u> a) Unlikely to be of much benefit onboard yachts where engine rooms are cleaner than those on commercial vessels and oily water separators are not often used. b) Additional piping and tank requirement would have cost implications over non-IBTS vessels. | No current plan to make this mandatory |
| Polar Code | DE | MSC/MEPC | This code is still in the drafting process but the scope, format and applicability have largely been agreed. The aim of the code is to improve the safety of ships operating in polar waters and to minimise their effects on the environment. The main issue still to be decided is how to define the category of vessel. It is expected that there will be 3 classes of polar ship: A, B and C and this will determine the thickness of ice the vessel will be certified to operate in along with a number of other operational parameters. | <u>Pros</u> a) The code will provide a high level of safety for ships and seafarers operating in polar waters. b) The code will help protect the polar environment. C) Because of | The code is scheduled for completion in 2012 during DE 56 to be held in February. Implementation dates for new and existing vessels should be decided during this meeting. |

| Legislation | Sub-Committee | Committee | Description and likely impact | Pros and Cons | Entry into force |
|---------------------|---------------|-----------|---|---|---|
| | | | <p>The code is wide ranging and encompasses ship construction, machinery, LSA/FFA, operational procedures and crew training and certification.</p> <p>Compliant ships will be issued with a Polar Ship Certificate valid for 5 years and subject to annual surveys.</p> <p>The impact on the yachting industry will be high due to the comprehensive requirements of this code. Although relatively few yachts venture into polar waters, those that do will find compliance a complicated process.</p> | <p>the large emphasis on safety management, emergency preparedness and crew training, it is possible that the code may represent an opportunity for yacht management companies. Unmanaged vessels may find certification difficult and will need assistance with the various aspects of compliance.</p> <p><u>Cons</u></p> <p>a) Compliance will be costly in terms of ship construction, management and crew training.</p> <p>b) Increased bureaucracy may put yacht owners off and cause them to exit the market.</p> | |
| Recovery capability | DE | MSC/MEPC | <p>There will be an amendment to SOLAS requiring ships to demonstrate the ability to recover people from the water. There is no agreement at present regarding type of equipment or performance standards. It is expected that existing LSA on some vessels may be sufficient to comply with the proposed legislation.</p> <p>This will be a low impact requirement requiring at worst the purchase of additional relatively low cost LSA.</p> | <p><u>Pros</u></p> <p>a) Will assist yacht crews in the event of need to recover people from the sea.</p> <p><u>Cons</u></p> <p>a) Additional cost but expected to be minimal.</p> | Expected to enter into force on 1 July 2012 for new ships and for existing ships the first annual survey after this date. |

| Legislation | Sub-Committee | Committee | Description and likely impact | Pros and Cons | Entry into force |
|------------------------------------|---------------|-----------|--|---|--|
| Code on noise levels onboard ships | DE | MSC/MEPC | Although the noise levels specified within the Code are unlikely to be a problem for the yachting industry, the Code does include a requirement for designers/shipyards to provide calculated predictions of expected noise levels at the design stage and for these predictions to be submitted to the flag state for approval. The Code is still under development and the correspondence group has been re-established to determine which sections of the code should be made mandatory and those which should be recommendatory. | <u>Pros</u> a) Will establish maximum noise levels onboard ships <u>Cons</u> a) Administrative burden for shipyards to submit noise calculations to flag administrations during the design phase. b) Possible additional costs associated with sound-proofing, although not expected to be an issue for the yachting industry | Code is scheduled for completion in 2012 but entry into force has not yet been determined. Further information will be available after the next DE meeting in February 2012. |
| MARPOL Annex VI Regulation 13, NOx | MEPC | | The introduction of the Tier III standards in 2016 is expected to cause problems for the yachting industry and particularly for yachts in the 20m to 30m range. Currently the only means of complying with these emission regulations is through the treatment of exhaust gases using Selective Catalytic Reduction (SCR). The SCR units are large and heavy and the impact on yacht design could be severe. | <u>Pros</u> a) Reduced NOx emissions will be beneficial to the environment. <u>Cons</u> a) Possible large impact on yacht design and construction | 1 January 2016 |
| EEDI and SEEMP | MEPC | | The Engine Efficiency Design Index or EEDI will require new ships to be built to a minimum level of energy efficiency. The level of efficiency will increase incrementally over time as laid down in the legislation. Along with the EEDI is a requirement for a Ship Energy Efficiency Management Plan or SEEMP. This plan, which is ship-specific, will set out best practices for the | <u>Pros</u> a) Improved fuel efficiency can be beneficial to the environment and can reduce running costs b) Compliance with SEEMP will possibly | 1 January 2013 |

| Legislation | Sub-Committee | Committee | Description and likely impact | Pros and Cons | Entry into force |
|--------------------------------------|---------------|-----------|---|---|--|
| | | | <p>fuel efficient operation of the vessel.</p> <p>Currently yachts are not included in the EEDI regulations, neither are they specifically excluded which means they may be required to comply at a later date. The impact on the industry could be high if this becomes the case. It is expected that yachts will need to comply with the SEEMP regulation. This will have a low impact on the industry.</p> | <p>present an opportunity for management companies in assisting yachts with the production of their plans.</p> <p><u>Cons</u></p> <p>a) SEEMP is yet more paperwork and bureaucracy.</p> <p>b) EEDI could be a major issue for the industry if yachts are ultimately included in the regulations.</p> | |
| Market-Based Measures – MBM's | MEPC | | <p>In addition to the MARPOL amendments dealing with EEDI and SEEMP it is planned to introduce a carbon trading scheme or something similar to offset carbon emissions from shipping. At present it is not known how the yachting industry may be affected.</p> | <p><u>Pros</u></p> <p>a) Possible environmental benefits</p> <p><u>Cons</u></p> <p>a) Additional expense</p> | <p>Not known. It was planned to progress the matter at MEPC 62 but there was no time available. The issue will be taken up again at MEPC 63 in March 2012.</p> |
| Garbage | MEPC | | <p>There is a new requirement that discharge of all garbage into the sea is prohibited, with some exceptions i.e. certain food wastes, cargo residues and water used for washing deck and external surfaces containing cleaning agents or additives which are not harmful to the marine environment. The form of the Garbage Record Book has been amended accordingly. This will have a low impact on the industry but yachts will need to be aware of the new requirements and be able to demonstrate compliance through proper completion of the Garbage Record Book.</p> | <p><u>Pros</u></p> <p>a) More environmentally friendly than existing rules.</p> <p><u>Cons</u></p> <p>a) Could make onboard storage of garbage more of an issue for some yachts.</p> | <p>1 January 2013</p> |
| BA sets – low pressure warning alarm | FP | MSC | <p>Draft amendments to the FSS Code will make mandatory a low pressure alarm and a visual or other device which would alert</p> | <p><u>Pros</u></p> <p>a) Improved safety for crew</p> | <p>To be determined. Further information should become available at the next</p> |

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|---|---------------|-----------|--|--|--|
| | | | <p>the user when there was no less than 200 litres of air in the bottle.</p> <p>This will have a low impact on the industry</p> | <p><u>Cons</u></p> <p>a) Additional cost of compliant equipment, although not significant.</p> | FP meeting in July 2012 |
| Means of recharging air bottles for BA sets and communication equipment for fire-fighting teams | FP | MSC | <p>Draft SOLAS amendments were produced mandating means of recharging air bottles for BA sets and radio equipment for use between fire-fighters.</p> <p>This will have a low impact on the industry</p> | <p><u>Pros</u></p> <p>a) Improved safety for crew</p> <p><u>Cons</u></p> <p>a) Additional cost of compliant equipment, although not significant.</p> | To be determined but further information should become available at the next FP meeting in July 2012 |
| Means of escape from machinery spaces | FP | MSC | <p>Draft amendments to SOLAS regulation II-2/13.4 require two means of escape from machinery control rooms and two means of escape from an enclosed room within a machinery space. The intention being that these amendments would be applicable to new passenger and cargo ships only (presumably including commercial yachts).</p> | <p><u>Pros</u></p> <p>a) Improved safety for crew</p> <p><u>Cons</u></p> <p>a) Additional cost of compliance.</p> | To be determined but further information should become available at the next FP meeting in July 2012 |