MARINE ENVIRONMENT PROTECTION COMMITTEE  
65th session  
Agenda item 4  

MEPC 65/4/8  
15 February 2013  
Original: ENGLISH  

AIR POLLUTION AND ENERGY EFFICIENCY  

Tier III NO\textsubscript{x} emission standards and its impact on the superyacht sector  

Submitted by International Council of Marine Industry Associations (ICOMIA) and Superyacht Builders Association (SYBAss)  

SUMMARY  

Executive summary: This document summarizes three studies carried out to assess the impact of Tier III NO\textsubscript{x} emission standards on the commercial viability of certain yachts used for recreational purposes.  

Strategic direction: 7.3  

High-level action: 7.3.1  

Planned output: 7.3.1.1  

Action to be taken: Paragraph 23  

Related documents: MEPC 65/4/7, MEPC 65/INF.10 and MEPC 65/INF.15  

Introduction  

1 ICOMIA, the recreational marine industry's international trade association, has been at the forefront of the superyacht sector's work on the impact of the MARPOL Annex VI Tier III NO\textsubscript{x} regulation since 2010 when it became apparent this is not just an engine manufacturer issue. Superyachts are the term used for recreational vessels over 24 m in load line length. ICOMIA has been active in bringing together the yacht builders, engine manufacturers, classification societies, specialist catalyst and related equipment manufacturers to assess and attempt to resolve the challenges of fitting SCR equipment in superyachts. In addition, ICOMIA has made significant contribution to the Correspondence Group on Assessment of Technological Developments to Implement the Tier III NO\textsubscript{x} Emission Standards under MARPOL Annex VI (MEPC 65/4/7 and MEPC 65/INF.10).  

2 Following participation in the Correspondence Group and the recognition by the Group of specific concerns on recreational vessels, ICOMIA initiated three studies to examine and inform the specific impact of this regulation on the superyacht sector. These were:
A Design Study carried out by the superyacht builders to assess the impact of Tier III SCR installations on current and planned designs;

A Technical Study by Ricardo UK, a renowned engineering consultancy, which examined the feasibility and cost of redesigning, fitting and operating a number of alternative engine/emission reduction technologies; and

A Socio-Economic Study by Adroit Economics, which carries out similar studies for the UK government, to estimate likely customer and yacht builder responses and the consequent likely change in demand and orders for different types of yachts and the consequent impact on turnover, jobs and Gross Value Added (GVA).

The Super Yacht Industry

1 Superyachts are used for recreational purposes either as a private yacht or a mix of private and charter operation, the latter being principally a means of offsetting the operating costs. While the largest in operation is 13,000 GT, the majority of the fleet by number is less than 500 GT. Superyachts are ordered by the so-called Ultra High Net Worth Individuals (UHNWIs) who are exacting in their specification and demands. Most yachts are constructed in compliance with international conventions and classification society rules whether used privately or charter to maintain their value in the used yacht market. This concept of a "global" yacht will apply equally to the universal fitting of SCR to yachts whether, in the first instance, they expect to operate in a NO\textsubscript{x} ECA or not.

2 The high Compensated Gross Tonnage (CGT) factor of superyachts (three times that of passenger ships) illustrates their high added economic value\textsuperscript{1}.

3 The number of yachts of 24 m and above is currently 4,433. The order book currently totals 351 yachts with build costs per metre of hull length varying between €300 k to well over €1 m for the largest.

Main Conclusions of the Design Study

4 There is no question that SCR units can be fitted to superyachts. The issue is their impact on the commercial viability of the yacht. ICOMIA arranged for the leading builders to carry out studies on current and planned designs using parameters for SCR units provided by the two leading engine suppliers which represent over 90 per cent of the superyacht market. The SCR parameters were also verified by an independent SCR consultant and Ricardo which was contracted to complete the Technical Impacts Study. The design study covered the following:

.1 14 yards (Italy, Netherlands, New Zealand, Taiwan, UK and USA);
.2 25 designs;
.3 Loadline length 24 to 66 m;
.4 Gross Tonnage 148 to 2,200 – most <500GT;
.5 Planning, semi-displacement and displacement; and
.6 Installed propulsion power 2,160 to 10,320 kW.

The impact on yacht accommodation is shown in figure 1 below:

![Figure 1](image)

It can be seen that total guest accommodation will reduce in area by 10-15 per cent which in reality means at least one guest cabin (typically out of between four and five) will be lost. This has immediate impact on the commercial viability of the yacht. This will be examined in more detail in the report on the Socio-Economic Study.

In addition to the design study, the yards contacted a selection of their operational yachts (total 31) and obtained engine use data from their engine Electronic Control Unit (ECU). This found that the average annual engine hours per yacht totalled 277.

The following engine load data was also obtained from the ECUs:

![Figure 2](image)

The significance of this latter data will be explained in the Technical Impacts Study Report.

**Main Conclusions of the Technical Study**

Ricardo assessed the four NOx emissions reduction technologies which were listed in the report of the Correspondence Group. These were:

1. Selective Catalytic Reduction – SCR;
2. Exhaust Gas Recirculation – EGR;
3. Miller Cycle; and
Summary of Technology Assessment

Both SCR and EGR can meet Tier III NOx emissions targets. Cooled EGR is an alternative, but requires significant changes either to the base engine design to accept higher cylinder pressures and to install a complex, bulky 2-stage boosting system, or replacement of existing engines with engines with swept volumes 20-25 per cent larger than the current engine. The risks of sulphuric corrosion within the EGR circuit will remain a concern unless very low sulphur fuel <0.005%S (<50ppmS) is available since size prevents the fitting of scrubbers. SCR and EGR will both have very significant cost, size and mass impacts on yachts. Miller Cycle does not achieve the emission limits required by Tier III and water injection technologies are not demonstrated for Tier III on recreational yachts.

Summary of SCR Application

SCR is the most feasible technology to meet Tier III NOx emissions regulations for superyachts. The Study calculated the following impacts, per yacht, assuming two engines fitted:

1. Cost €200-€250k (including new components plus engineering design and development costs but excluding modifications to the yacht model, re-design, installation and commissioning);
2. Weight 3.9-4.6t (includes urea and urea tank, but excludes extra ballast and fuel); and
3. Volume 5.5-8.5m³ (catalysts, added exhaust length, dosing cabinet, urea tank, etc.).

The preliminary catalyst sizes proposed by key engine manufacturers are consistent with Ricardo estimates of SCR volume requirements for marine applications. Marine applications require large catalyst volume since fuel sulphur content is assumed to be of 0.05-0.1%S (500-1000 ppmS) at Tier III. Consequently the SCR catalysts will need to be approximately double the size of those used with ultra-low sulphur fuel (such as automotive engines) and since sulphates (due to sulphur in fuel) can cause partial blockage of SCR catalyst cells – the catalysts must be sized to avoid constriction due to the sulphur in the fuel. Furthermore, if there is a risk of higher levels of sulphur in fuel, then even larger catalysts will be required. Only a limited range of SCR catalyst shapes can be offered by engine manufacturers due to the high cost of engineering (development and certification) of each individual exhaust/catalyst/engine configuration and the low market demand from this sector. SCR is not operable when exhaust temperature is <250°C. Typical usage pattern data for recreational yachts in this study indicated that more than 50 per cent of operational time is at below 20 per cent engine load which is typically below this key temperature.

Main Conclusions of the Socio-Economic Study

Adroit Economics noted from the Design Studies the only ways the redesigned engine and additional equipment can be fitted in these yachts is increasing the size of the engine room via reducing cabin or aft storage space for crucial items such as the yacht tender, or by increasing the length of the yacht.

All of these options will result in either reduced cabin space (for guests) or additional construction costs to extend the length of the yacht by 1.5 m. For existing models still in production in 2016, this could mean re-tooling and remoulding. For new models, guest cabin arrangements will offer significantly reduced value compared to pre-2016 vessels.
This applies across the whole range of affected yachts – from 24 m L up to 500GT and beyond, but is most acute for the 24-30 m range

15 This study considered the implications across the whole range of yachts but has focussed particular attention on the 24-30 m segment of the market.

The above considerations left many stakeholders believing a complete segment of the market will disappear

16 The loss of cabin space and/or additional costs may mean that some (or all yards) decide to cease production of the 24-30 m L size range of yachts. If this is the case, and our research (see below) suggests that it is very likely the case, then this will result in change in demand and orders for other yachts.

17 These impacts of the SCR will result in changes in levels of production and in production costs, and consequent changes in employment and GVA. The mix of operational yachts will also change as a result, with an increase in demand for yachts just below 24 m L, since their accommodation will be superior to that in the SCR fitted 24-30 m range, and above 30 m along with increased purchase of unsold stock of pre-2016 built 24-30 m yachts.

18 Additional observations include the following:

.1 It is very common for yacht owners to buy larger yachts each time they change yachts. If production of a complete segment of the market ceases (the 24-30 m segment), this will remove a segment of the trade-up ladder, which may well interrupt this progression.

.2 Lengthening yachts by 1.5 m to accommodate the SCR equipment might seem a simple and the most obvious solution to the problem. This however involves yards in design costs, in providing new moulds for GRP yachts and in additional manufacturing costs of circa €1.5 m per yacht. Lengthening the vessel may also result in higher specification engines being required to enable the same performance, resulting in further additional costs.

19 Having assessed likely customer attitudes to the changes caused by fitting SCR, Adroit Economics modelled three builder scenarios which were tested with three likely customer responses. The scenarios and consequences are shown in the table below:

<table>
<thead>
<tr>
<th>Builder behaviour scenarios</th>
<th>Net jobs (FTE)</th>
<th>6 yr NPV(^3) @ 3.5%</th>
<th>Net cost benefit (cost per tonne of NO(_x) reduction)(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 24-30 m yachts cease production</td>
<td>- 2,739</td>
<td>-€817,677,712</td>
<td>€178,561</td>
</tr>
<tr>
<td>2 Some 24-30 m yachts remain in production by increasing the yacht length by 1.5 m</td>
<td>- 2,969</td>
<td>-€1,081,853,752</td>
<td>€228,729</td>
</tr>
<tr>
<td>3 Some 24-30 m yachts remain in production by reducing guest cabin space by 1.5 m</td>
<td>- 2,831</td>
<td>-€884,507,211</td>
<td>€190,647</td>
</tr>
</tbody>
</table>

\(^2\) Full Time Equivalent  
\(^3\) Net Present Value  
\(^4\) Accumulated over 6 years NO\(_x\) reduction and 6 years cost
Interpreting the results

20 Adroit's view is that scenario 1 (see above "24-30 m yachts cease production") is the most likely. The literature suggests that the cost range for NO\textsubscript{x} reductions across other sectors is between €2,847 to €4,204\textsuperscript{5} per tonne which is 42 to 54 times less than the cost calculated under scenario 1, with an associated job loss of 2,700 to 2,900 and GVA loss of €0.8 to €1billion over a 6-year period (discounted at 3.5%). In addition, the viability of whole yards/companies in certain cases could be significantly affected – Adroit cannot model this but several yards indicated this would be the case during stakeholder consultation.

Conclusion of the Studies

21 The superyacht industry has been addressing the challenges of Tier III NO\textsubscript{x} emission standard since 2010. Design studies demonstrate that, in yachts up to at least 500 GT, engine rooms will have to increase in length to such an extent that their commercial viability is adversely impacted. SCR is the only feasible technology for superyachts to achieve Tier III but with notable size and costs impacts. Were SCR to be implemented with the currently available technologies, the industry faces the loss of the most commercially vibrant market sector with significant losses of revenue and jobs. Furthermore the costs of NO\textsubscript{x} reduction per tonne are wholly disproportionate to the results achieved and in comparison with other industries especially when annual average engine hours are only 277 during which the SCR will operate for less than half that time. The co-sponsors note that the criteria for designating an ECA include relative costs compared with land-based controls and economic impacts on shipping.

22 Looking to the future, further significant reductions in SCR installations for superyachts which would remove the adverse consequences of the currently offered technology is dependent on two factors, a global availability of ultra-low sulphur diesel <0.005%S (<50ppmS) and businesses seeing if there is opportunity for developing optimized solutions for this sector given the low market demand.

Action requested of the Committee

23 The Committee is invited to consider the contents of this document and of MEPC 65/INF.15, and take action as appropriate.

\textsuperscript{5} Figures taken from the impact assessment for Euro VI – emissions from on-road heavy duty vehicles and on access to vehicle repair information.