PREVENTION OF AIR POLLUTION FROM SHIPS

Report on the outcome of the second Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships

Note by the Secretariat

1.1 The second Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships took place at IMO Headquarters from 9 to 13 March 2009 under the chairmanship of Mr. Koichi Yoshida (Japan). More than 200 representatives from Member Governments and observer organizations participated in the five-day meeting.

1.2 The second Intersessional Meeting was attended by delegates from the following Member Governments:

ARGENTINA           LIBERIA
AUSTRALIA           MALTA
BAHAMAS             MARSHALL ISLANDS
BELGIUM             MEXICO
BOSNIA AND HERZEGOVINA NETHERLANDS
BRAZIL              NORWAY
CANADA              PANAMA
CHILE               PHILIPPINES
CHINA               POLAND
COOK ISLANDS        REPUBLIC OF KOREA
CYPRUS              SAUDI ARABIA
DENMARK             SINGAPORE
FINLAND             SOUTH AFRICA
FRANCE              SPAIN
GERMANY             SWEDEN
GREECE              SYRIAN ARAB REPUBLIC
INDIA               TURKEY
IRAN (ISLAMIC REPUBLIC OF) UNITED KINGDOM
ITALY               UNITED STATES
JAPAN
by a representative from the following Associate Member of IMO:

HONG KONG, CHINA

by observers from the following intergovernmental organizations:

EUROPEAN COMMISSION (EC)
MARITIME ORGANIZATION FOR WEST AND CENTRAL AFRICA (MOWCA)

by observers from the following non-governmental organizations:

INTERNATIONAL CHAMBER OF SHIPPING (ICS)
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
INTERNATIONAL TRANSPORT WORKERS’ FEDERATION (ITF)
INTERNATIONAL RADIO MARITIME COMMITTEE (CIRM)
BIMCO
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF)
FRIENDS OF THE EARTH INTERNATIONAL (FOEI)
COMMUNITY OF EUROPEAN SHIPYARDS' ASSOCIATIONS (CESA)
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
SOCIETY OF INTERNATIONAL GAS TANKER AND TERMINAL OPERATORS LIMITED (SIGTTO)
CRUISE LINES INTERNATIONAL ASSOCIATION (CLIA)
INTERNATIONAL ASSOCIATION OF DRY CARGO SHIPOWNERS (INTERCARGO)
ASSOCIATION OF EUROPEAN MANUFACTURERS OF INTERNAL COMBUSTION ENGINES (EUROMOT)
THE INSTITUTE OF MARINE ENGINEERING, SCIENCE AND TECHNOLOGY (IMarEST)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERFERRY
INTERNATIONAL BUNKER INDUSTRY ASSOCIATION (IBIA)

**TERMS OF REFERENCE**

1.3 The meeting had the following Terms of Reference (ToR) adopted by MEPC 58 (paragraph 4.37 of document MEPC 58/23 and annex 12):

Taking into account submissions for the intersessional meeting and relevant background documents, the second Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships is instructed to:

Taking into account the outcome of MEPC 58:

.1 regarding the Energy Efficiency Design Index for new ships, consider towards finalization:

.1 the Energy Efficiency Design Index formula taking into account any trial application of the Index by calculation;
.2 consider towards finalization the review of the interim guidelines on the Energy Efficiency operational index (MEPC/Circ.471);

.3 consider towards finalization the introduction of a management tool for all ships, taking into account the Ship Efficiency Management Plan considered during MEPC 58;

.4 consider towards finalization the guidance on best practices and other voluntary operational measures including reference text to be incorporated in the regulatory framework;

.5 consider possible impacts on the shipping sector from the measures envisaged; and

.6 present a written report to MEPC 59.

OPENING SESSION

1.4 The Director of the Marine Environment Division, Mr. Miguel Palomares, on behalf of the Secretary-General, welcomed the delegates in an opening speech where he stated that the importance of the meeting could not be over-emphasized as the Marine Environment Protection Committee would heavily depend on the outcome. The meeting would focus on two of the pillars in IMO’s GHG work; the technical and operational measures, leaving the third pillar, the market-based instruments, as well as the policy discussion and consideration of application to the Committee. Mr. Palomares was confident that the spirit of cooperation, for which this Organization was renowned, would prevail in the quest for sound and balanced decisions on which to base its advice to the MEPC, and that the meeting under the able leadership of Mr. Yoshida of Japan, would be able to make good progress and arrive at solutions that would serve well the causes of protection of the global marine and atmospheric environment. He closed by wishing the meeting every success and the best of luck.

1.5 The Chairman of the intersessional working group stated that the most important issue was that everybody involved in this week’s meeting fully recognized that this was a technical working group instructed to conduct technical consideration and any political statements should be kept for MEPC 59, which would be the correct body for policy debates and decisions. Although the meeting would have both tasks and submissions covering regulatory aspects and verification methods under the Terms of Reference 1.2 and 1.3, the group would leave the debate and decisions on what ships or States to apply, or what regulatory framework to use, to MEPC 59. The group would only set the table, enabling MEPC to consider application at the appropriate point in time and the results of the intersessional working group meeting would be reported to MEPC 59.
STATEMENTS

1.6 The delegation of China provided a general statement at the opening session, which is set out in annex 1 to this report.

ADOPTION OF THE AGENDA

1.7 The second Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships (GHG-WG 2) (the group) adopted its agenda as set out in document GHG-WG 2/1.

2 CONSIDERATION OF THE ENERGY EFFICIENCY DESIGN INDEX FOR NEW SHIPS

Order of discussions

2.1 Following a proposal by the Chairman, the group agreed to consider the various elements and submissions under this agenda item in the following order:

.1 general comments on the EEDI;
.2 scope of the EEDI (implementation issues and ships types to be included);
.3 matters related to passenger ships and ro-ro ferries;
.4 auxiliary power, shaft generators and diesel-electric propulsion;
.5 main engine and propulsion power issues;
.6 waste heat and energy recovery systems;
.7 specific fuel consumption (SFC) to be used in the EEDI;
.8 matters related to coefficient “fw”;
.9 speed (Vref) to be used in the EEDI;
.10 Carbon to CO2 factors (Cf) to be used in the EEDI;
.11 matters related to ice strengthening;
.12 baselines for the EEDI;
.13 regulatory framework; and
.14 verification of the EEDI.

2.2 The group welcomed a presentation by the Danish delegation providing background on what the EEDI actually was meant to express as well as a brief explanation of the different elements in the formula as it stands, following the work at MEPC 58 in October 2008.

General comments on the EEDI

2.3 Under this sub-item the group considered the following documents:

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<thead>
<tr>
<th>Document</th>
<th>Country</th>
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<tbody>
<tr>
<td>GHG-WG 2/2/8</td>
<td>Sweden</td>
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<tr>
<td>GHG-WG 2/2/10</td>
<td>China</td>
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<tr>
<td>GHG-WG 2/2/12</td>
<td>Republic of Korea</td>
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<td>GHG-WG 2/2/22</td>
<td>CESA</td>
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</table>

.1 The delegation of Sweden, in document GHG-WG 2/2/8, emphasized that ro-ro cargo and ro-ro passenger (ro-ro/ro-pax) services provide a large percent of import and export in Europe. Ro-ro/ro-pax vessels were typically custom-built for a specific trade and establishing an EEDI based on statistics for these segments was challenging. The special need for flexible power solutions for ships engaged in
short-sea-shipping and for ro-ro/ro-pax needed to be recognised as well as the possibility of modal shift to less energy efficient transport modes. In light of the above, Sweden presented an alternative methodology for how to calculate an EEDI, less dependent on correction factors than the current draft EEDI, a methodology that better met the particularities of ro-ro/ro-pax ships, i.e. to relate the index to required power rather than installed power. Recognizing the need to finalize the EEDI, but also recognizing how important it was not to penalize ro-ro/ro-pax services; Sweden advocated to invest more time and to develop a dedicated index for ro-ro/ro-pax ships, as it would be done for ships with diesel-electric propulsion, and offered to lead this work;

.2 The delegation of China, in document GHG-WG 2/2/10, supported the establishment of an EEDI formula to improve the energy efficiency of new ships. China had conducted trials to verify the practicability and feasibility of the draft EEDI formula and believed that a range of factors needed to be further considered and clarified. China advocated that an assessment of impacts on ship’s energy efficiency of IMO new standards on maritime safety and marine environment should be undertaken;

.3 The delegation of the Republic of Korea, in introducing document GHG-WG 2/2/12, emphasized that refinement and improvement of the current EEDI formula should aim at making it capable of covering all types of propulsion and power generation systems available for ships, as well as, all energy saving technologies which may be developed in the future. The proposed draft EEDI only considered CO$_2$ emission from prime movers producing propulsion and electric power for normal maximum sea load. “Energy saving technologies” should be categorized in two cases: the first whereby the performance of the prime mover was affected by energy saving technologies and the second where energy saving technologies captures CO$_2$ emission; and

.4 The observer delegation of CESA, in document GHG-WG 2/2/22, emphasized that further improvements of the EEDI concept could be anticipated by modifications of the baseline and that further trial applications to existing ships and new designs were needed. It was also recommended to consider further development of the EEDI formulation for ships with diesel-electric power formulation with specific reference to the design principles of modern cruise ships. CESA had together with TUHH used the EEDI formula and calculated trial applications of 66 ro-ro and ro-pax ferries, which were often highly optimised to the customer’s request, and the results displayed that complex ship types shows a higher scatter than standard ship types such as bulk carriers, tankers and container vessels. The foremost factor influencing the EEDI was the speed. This could give misleading results: highly optimised ships, designed by means of state-of-the-art tools for hydrodynamics and structural optimization and best available energy efficient equipment, could appear to be less efficient than an outdated and badly designed ship for the sole reason that the former is capable of operating at a slightly higher speed or featured additional redundancy power. The index system should acknowledge that ship design has to respect the transport task the ship was intended for and that innovation should be acknowledged and rewarded.
2.4 The group exchanged views on the subject and the following points were highlighted:

.1 further work was needed to improve the current formula;

.2 IMO’s focus should first be on the large ship segments already within the scope of the draft EEDI and thereafter, may be expanded to other ship types that would need conceptual different approaches; and

.3 short-sea-shipping has several special characteristic not directly comparable with trans-ocean shipping and compete mainly with land-based transport systems.

2.5 The group agreed that for the discussion of the group, the interim guidelines agreed at MEPC 58 (annex 11 to MEPC 58/23) should be used as the base document. In particular, the group agreed to keep:

.1 the concept of formula of EEDI;

.2 75% of MCR should be used for $P_{ME}$; and

.3 empirical formula for determination of $P_{AE}$.

Scope of the EEDI (implementation issues and ship types to be included)

2.6 Under this sub-item the group considered the following documents:

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<tr>
<th>Relevant Parts</th>
<th>Document Code</th>
<th>Country</th>
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<tbody>
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<td>(except paragraphs 9 – 10)</td>
<td>GHG-WG 2/2/1</td>
<td>Netherlands</td>
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<tr>
<td>GHG-WG 2/2/16</td>
<td>Japan</td>
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<tr>
<td>GHG-WG 2/2/17</td>
<td>Japan</td>
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.1 The delegation of the Netherlands, in document GHG-WG 2/2/1, fully supported the efforts of IMO to develop effective measures to reduce greenhouse gases. The document presented the outcome of a study conducted in relation to Dutch designed and built vessels. The conclusions of the study provided proposals for further fine tuning/improvement of the formula and conclusions on the scope of the formula. With regard to the scope of the formula, it was found that the degree of correlation between vessels improved with increasing ship size. To overcome the challenges found for smaller vessels, and not to delay the introduction of the EEDI, a phased approach, was recommended by starting with new vessels above [20,000] DWT and at the same time develop interim EEDI formula for the smaller types of vessels;

.2 The delegation of Denmark, in document GHG-WG 2/2/3, underlined that it was important that ship yards and shipowners could not pick and choose between the ship-types covered by the EEDI and proposed draft definitions for the seven relevant ship types to counteract this;
3 The delegation of Japan, in document GHG-WG 2/2/16, provided information on the elements necessary for the establishment of an EEDI scheme, focusing on the verification and certification process, and proposing text for the regulatory framework as well as skeleton draft guidelines on verification and certification of the EEDI; and

4 The delegation of Japan, in introducing document GHG-WG 2/2/17, provided an analysis and considerations of various elements relating to calculation of EEDI and possible amendments to the interim Guidelines on the calculation of the EEDI for new ships based on trial calculation conducted for 276 relevant vessels. Japan proposed to add missing definitions/explanations and to modify the calculation method for energy recovery devices.

2.7 In the ensuing debate the following points were highlighted:

1. the index should be widely applied and cover the large segments of shipping in order to promote tangible energy efficiency and to achieve real emission reductions;

2. the formula as agreed by MEPC 58 may not be appropriate for all ship types and concerns were expressed over inclusion of ro-pax vessels and the possible need for better resolution for passenger vessels were pointed out;

3. multi-purpose built vessels posed an additional challenge;

4. implementation would be simplified by setting the lower tonnage threshold relatively high, e.g., 20,000 DWT, but a smaller share of new vessels and thereby emissions would be covered;

5. the lower tonnage threshold did not need to be considered at this stage but should be considered together with the wider application issue;

6. it was still possible to compensate for the peculiarities related to small and purpose built ships at the application stage by applying additional correction factors; and

7. the level of correlation may be used as criteria for what ship types that may be included in the scope.

2.8 The group agreed to use the definition of ship types proposed by Denmark in document GHG-WG 2/2/3. The group also agreed, in principle, to the categorization of ship sizes as proposed by Japan in document GHG-WG 2/2/16, annex 3 with a change from [10,000] to [X].
Matters related to passenger ships and ro-ro ferries

2.9 Under this sub-item the group considered the following documents:

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<tr>
<th>Document</th>
<th>Origin</th>
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<tbody>
<tr>
<td>GHG-WG 2/2/2</td>
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<tr>
<td>GHG-WG 2/2/6</td>
<td>Denmark</td>
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<tr>
<td>GHG-WG 2/2/8</td>
<td>Sweden</td>
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<tr>
<td>GHG-WG 2/2/13</td>
<td>INTERFERRY</td>
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<tr>
<td>GHG-WG 2/2/19</td>
<td>ICS, CLIA, INTERFERRY</td>
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<tr>
<td>GHG-WG 2/2/21</td>
<td>and the Marshall Islands</td>
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.1 The delegation of Denmark, in document GHG-WG 2/2/6, advocated that DWT did not provide the most appropriate capacity parameter for ro-ro passenger ships and proposed to use Gross Tonnage (GT) as it was a measure of volume and reflected the size of the accommodation/ship used for passengers;

.2 The delegation of Sweden, in document GHG-WG 2/2/8, supported the use of GT as capacity parameter for passenger and ro-pax vessels;

.3 The observer delegation of INTERFERRY, in document GHG-WG 2/2/13, argued that the draft EEDI was suitable for ship types engaged in trans-ocean trades where seagoing transit was the dominating mode of operation while for ships engaged in short sea shipping, providing line services dictated by a timetable, and for ships having unconventional propulsion arrangements the proposed methodology did not grant the intended fair basis for comparison. It also argued that an effective EEDI should be divided in two parts: addressing propulsion and auxiliary power separately, and proposed amendments to that effect;

.4 The cosponsors, in document GHG-WG 2/2/19, advocated that IMO’s focus should be on ships with conventional design in trans-oceanic trades while ships with more complex designs and configurations should be considered thereafter;

.5 The observer delegation of RINA, in document GHG-WG 2/2/2, agreed that both the use of Displacement and GT as capacity parameters have inherent uncertainties but that the use of DWT has advantages over the use of Displacement and GT; and

.6 The observer delegation of CLIA, in introducing document GHG-WG 2/2/21, proposed a calculation method for EEDI for passenger ships as an extension of the current formula to suit passenger ships’ configurations addressing a wide range of propulsion system technologies, auxiliary power, waste heat recovery systems, shaft generators and diesel-electric propulsion.

2.10 The following points were highlighted during the subsequent exchange of views:

.1 The use of GT as capacity parameter for passenger vessels may favour ships with large superstructure and increased use of ballast;
.2 the uncertainties in use of GT for passenger vessels may be compensated by using a correction factor taking into account the number of passengers, lane-metres and other peculiarities for passenger and ro-pax vessels; and

.3 ro-pax vessels often have complex design and act as bridges in the transport chains competing also with land-based transport modes.

2.11 The group agreed that EEDI as improved at this session of the group should apply as widely as possible. However, the group noted that the EEDI may not be able to apply to certain types of ships which have diesel-electric propulsion, turbine propulsion and hybrid propulsion systems.

Statement by ICS

2.12 The observer delegation of ICS provided the following statement:

“Until now we have understood that the application of the revised EEDI formula as it is now presented does not apply to electrically propelled or other ships with unconventional – if we can include steam turbines as such – or novel power and propulsion arrangements.

We have also heard from Japan, INTERFERRY and others of their specific concerns related to the application of the formula to passenger and ro-ro passenger ships with conventional propulsion and your proposal Mr. Chairman, to develop the electrical load balance application further.

Mr. Chairman, in order to seek a way forward that makes the best available use of our time here, and given that we have a formula that generally appears to be acceptable to the majority when applied to conventional ship types, can we suggest that we concentrate on developing the EEDI for these ship types now. After all, if we look at passenger ships – including cruise and ro-ro passenger ships, and if we remember correctly the results of the last update of the consortium report on GHG emissions from ships, this sector accounts for some 10 per cent only.

I therefore suggest, that we exclude from discussions this week only all passenger ships – including passenger ro-ro’s, and hybrid ships, ships using all electric propulsion, steam turbines etc. Please be assured that the industry hopefully, together with other stakeholders, will continue to work on and develop updated proposals to those submitted here and update MEPC 59 on progress, with a view to having a firm proposal on the table.

This will allow the development and calculation of the necessary guidance for the load balance calculation and approval including the relevant additional baselines.”

2.13 The view expressed by ICS in the above statement was supported by many delegations while some other delegations expressed disagreement.

2.13bis The group noted that interested member States and observer organizations may submit proposals to MEPC 59 on the EEDI for specific ship types (e.g., electrically propelled ships, vessels designed specially for short-sea-shipping (ro-ro, ro-pax, and ferries), ships with steam turbines and other complex ship types such as hybrid ships).
2.14 The group agreed to use GT for the capacity of passenger ships and ro-ro passenger ships in the EEDI. The group also agreed that this view should be forwarded to the correspondence group dealing with EEOI matters for its information.

**Auxiliary power, shaft generators and diesel-electric propulsion**

2.15 Under this sub-item the group considered the following documents:

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<th>Relevant Parts</th>
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<tbody>
<tr>
<td>(paragraphs 6 – 15)</td>
<td>GHG-WG 2/2 Netherlands</td>
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<td>(paragraphs except paragraph 3)</td>
<td>GHG-WG 2/2 RINA</td>
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<td>(paragraphs 3 – 10)</td>
<td>GHG-WG 2/2/4 Denmark</td>
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<td>(paragraphs 3 – 4)</td>
<td>GHG-WG 2/2/5 Denmark</td>
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<tr>
<td>(paragraphs 11 – 12, 19 – 20)</td>
<td>GHG-WG 2/2/8 Sweden</td>
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<tr>
<td>(paragraphs 3 – 4)</td>
<td>GHG-WG 2/2/10 China</td>
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<tr>
<td>(paragraphs 11 – 12, 19 – 20)</td>
<td>GHG-WG 2/2/17 Japan</td>
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<tr>
<td>(paragraphs 3 – 10)</td>
<td>GHG-WG 2/2/19 ICS, CLIA, INTERFERRY and the Marshall Islands</td>
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<td>GHG-WG 2/2/22 CESA</td>
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2.16 The group agreed that $f_j$ should also be introduced in the calculation for shaft motor power $P_{PTI}$.

2.17 The group also agreed that $V_{ref}$ should be determined based on $0.75 \times (MCR_{ME} - P_{PTO})$ ($P_{PTO}$ is shaft generator output) if such shaft generator was installed.

2.18 The group further agreed that for ships where the $P_{AE}$ value calculated by the empirical equation to determine $P_{AE}$ was significantly different from the total power used at normal seagoing, e.g., in cases of passenger ships, $P_{AE}$ can be estimated by the total electric power (excluding propulsion) at normal sea going, to be given in the electric power table, divided by the conversion factor (0.9) from diesel engine power to electric power. In this connection, the group noted that the electric power table is often verified and approved by the Administration/Recognized Organization because it can be the documentation relating to the SOLAS Chapter II-1, Part D, regulation 40.1.1.

2.19 The group agreed to include the factor $(-f_{eff} P_{AE_{eff}})$ for the auxiliary power reduction due to innovative electrical energy efficient technology measured at $P_{ME}$ and, if such technology was a waste energy recovery system, $f_{eff}$ should be taken as 1.0.

2.19bis Some delegations expressed concerns related to the availability of electric power tables from the common database for calculation of baselines.

**Main engine and propulsion power issues**

2.20 Under this sub-item the group considered the following documents:

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<tbody>
<tr>
<td>(paragraphs 27 – 28)</td>
<td>GHG-WG 2/2/8 Sweden</td>
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<tr>
<td>(paragraph 7)</td>
<td>GHG-WG 2/2/13 INTERFERRY</td>
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2.21 The group agreed to consider this issue together with the issue of matters related to passenger ships and ro-ro ferries (see paragraphs 2.15 to 2.20 above).
Waste heat and energy recovery systems

2.22 Under this sub-item the group considered the following documents:

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<th>Relevant parts</th>
<th>Document Details</th>
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<tbody>
<tr>
<td>paragraph 3</td>
<td>GHG-WG 2/2/2 RINA</td>
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<tr>
<td>paragraph 5</td>
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<td>paragraph 9</td>
<td>GHG-WG 2/2/10 China</td>
</tr>
<tr>
<td>paragraphs 39 – 43</td>
<td>GHG-WG 2/2/12 Republic of Korea</td>
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<td></td>
<td>GHG-WG 2/2/17 Japan</td>
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.1 The observer delegation of RINA, in document GHG-WG 2/2/2, underlined that the current formulation related to the auxiliary engines was not sufficiently generic and was based on one specific, and unusual, system (waste heat recovery generating electricity which is fed to a motor providing supplementary power to the propeller shaft). A more common use of waste heat recovery was to generate electricity for auxiliary purposes;

.2 The delegation of Denmark, in document GHG-WG 2/2/4, proposed that calculation of the power generated by the waste heat recovery system should be verified through a three step process: step 1 to be carried out in the early design stage when the engine type is decided; step 2 should be carried out during the shop test of the main engine; and step 3 should be carried out during the sea trial;

.3 The delegation of China, in document GHG-WG 2/2/10, emphasized that since \( P_{ME} \) and \( P_{PTI} \) denote output power of the propulsion engines while \( P_{WHR} \) and other power parameters are related to the electric power, the standards for determination of power parameters were inconsistent and needed to be unified. The EEDI formula indicated that the reduced main engine power \( P_{eff} \) should be deducted due to new energy-saving technologies, but it did not explain how to reduce \( P_{eff} \) and the definition of new energy-saving technologies was not clear. Various kinds of new energy sources such as wind, solar, bio-energy, wave energy, whose energy efficiency (power generated) also varies with different application of energy-saving, devices should be accommodated;

.4 The delegation of the Republic of Korea, in document GHG-WG 2/2/12, expressed the view that “energy-saving technologies” could be dealt with by categorizing them into two cases: the first one where the performance of the prime mover for propulsion and electric power generation was affected by energy-saving technologies and the other, where energy-saving technologies capture the \( CO_2 \) emissions; and

.5 The delegation of Japan, in document GHG-WG 2/2/17, proposed to include the effect of shaft generators in line with those of waste heat recovery systems with a minor amendment of the definition. The Interim Guidelines stipulated that the effect of energy recovery devices onboard was to be deducted from the total \( CO_2 \) emissions from the vessel; however, it may happen that the effect of such devices (the power that can be recovered) could be larger than the power of shaft motors and auxiliary engines.
2.23 In the ensuing debate the following points were highlighted:

.1 Alternative energy saving devices are covered by the fourth element of the numerator and the effect of such devices needed to be considered in detail for each new technology.

2.24 The group agreed to consider this matter together with the issues on auxiliary power, shaft generators and diesel-electric propulsion (see paragraphs 2.15 to 2.20 above).

**Specific fuel consumption (SFC) to be used in the EEDI**

2.25 Under this sub-item the group considered the following documents:

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<th>Document</th>
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<tr>
<td>Paragraph 6</td>
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<tr>
<td>Paragraphs 25-34, 44-47</td>
<td>GHG-WG 2/2/17</td>
<td>Japan</td>
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.1 The delegation of China, in document GHG-WG 2/2/10, proposed that definitions should be given to ship's auxiliary fuel consumption in case multiple types of generators were installed. Furthermore, for engines below the MARPOL Annex VI requirements (130 kW), the diesel engines were not required to get EIAPP certificates and the fuel data may not have been verified; and

.2 The delegation of Japan, in document GHG-WG 2/2/17, underlined that SFC was measured during factory acceptance tests and the results documented in the technical file of the Engine International Air Pollution Prevention Certificate (EIAPPC), and that the values recorded in the technical file should be used for calculation of the EEDI as described in paragraph 7 of the Interim Guidelines. It should however, be noted, that test fuel oil used for NOx emission examination, is different from the fuel oil used in actual ship operation. To determine SFC_{AE} when two or more types of auxiliary engines are installed in the same vessel either a simple mean or a weighted average may be used.

2.26 The following were noted during the group’s exchange of views on the matter:

.1 only a limited number of ships above 400 GT would have auxiliary engines with power output less than 130 kW and the total emissions would only represent a very small fraction of the total ship emissions;

.2 treatment of engines with power output less than 130 kW may be left to the Administration based on fuel data provided by the manufacturer; and

.3 while simplification of the EEDI formula may facilitate smooth and timely implementation, it may also restrict the tools available for ship designers and shipowners.

2.27 Noting the fact that fuel used in actual operation is unknown at the design stage of ships and also that marine fuel may be dramatically changed according to the revision to MARPOL Annex VI adopted at MEPC 58, the group agreed that $SFC$ in the EIAPP Certificate shall be used without any adjustment.
2.28 The group agreed that when different types and sizes of auxiliary engines are installed, average $SFC_{AE}$ weighted by the engine output power shall be used.

2.29 The group agreed that if an EIAPP certified $SFC$ value is not available due to the small power of the engine (less than 130 kW), $SFC$ specified by the manufacturer and endorsed by a competent authority should be used.

**Matters related to Coefficient “fw”**

2.30 Under this sub-item the group considered the following documents:

<table>
<thead>
<tr>
<th>Relevant Parts</th>
<th>Document Identifier</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant parts (paragraph 5)</td>
<td>GHG-WG 2/2/2</td>
<td>RINA</td>
</tr>
<tr>
<td>Relevant parts (paragraph 7)</td>
<td>GHG-WG 2/2/10</td>
<td>China</td>
</tr>
<tr>
<td>Relevant parts (paragraph 11)</td>
<td>GHG-WG 2/2/12</td>
<td>Republic of Korea</td>
</tr>
<tr>
<td>Relevant parts (paragraph 15)</td>
<td>GHG-WG 2/2/15</td>
<td>Japan</td>
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</table>

.1 The observer delegation of RINA, in document GHG-WG 2/2/2, expressed the view that the current value to be used for $fw$ is based on weather conditions in the Pacific and assuming that the ship will operate in head winds and head seas of force 6 all its life. However, for many trades the Pacific did not constitute a significant sailing area. This could lead to designs optimized for far worse weather conditions than necessary; possibly resulting in less than optimum beam (Added resistance due to waves is related to the cube of ship beam);

.2 The delegation of China, in documents GHG-WG 2/2/10 and GHG-WG 2/2/11, advocated that Baufort scale 6 could not be universally representative for different types of ships under different climate zones. The reduction of voyage speed relates much to the operational environment, therefore, $fw$ should be removed in the EEDI formula; and

.3 The delegation of Republic of Korea, in introducing document GHG-WG 2/2/12, argued that $fw$ should be deleted to provide a fair basis for comparison depending on ship type and ship size and that the decrease of ship’s speed and the resulting fluctuation of CO$_2$ emission are to be considered in EEOI rather than EEDI in concept.

2.31 In the ensuing debate the following points were made:

.1 inclusion of $fw$ may provide further efficiency improvements compared to ships being optimised for calm conditions;

.2 the Goal Based standards (GBS) under development by IMO uses winter North Atlantic as its weather reference, a harmonisation should be considered;

.3 standard $fw$ curves would need to be developed for all ship types within the scope of the EEDI and significant work was needed; and
the goal under GBS was to ensure robust ships, hence the harsh weather conditions of the North Atlantic were highly relevant. But in relation to the EEDI it should be a weather condition reflecting the actual average or normal operational conditions to the extent possible.

2.32 Noting that the majority of those delegations that spoke supported the importance of a weather factor $f_w$ for EEDI and Japan’s intention to continue work on development of relevant guidelines on $f_w$, the group agreed to leave the parts relating to $f_w$ unchanged at this moment.

2.33 The group agreed that further consideration should be given to harmonization of the weather conditions for $f_w$ with other IMO instruments, in particular, for goal-based new ship construction standards (GBS), and invited Japan to take this into account in its development of the draft guidelines for determination of $f_w$.

**Speed ($V_{ref}$) to be used in the EEDI**, with introduction of the following documents:

2.34 Under this sub-item the group considered the following documents:

<table>
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<tr>
<th>Relevant Parts</th>
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<th>Country</th>
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<tbody>
<tr>
<td>(paragraphs 9 – 10)</td>
<td>GHG-WG 2/2/1</td>
<td>Netherlands</td>
</tr>
<tr>
<td>(paragraph 10)</td>
<td>GHG-WG 2/2/12</td>
<td>Republic of Korea</td>
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</table>

1. The delegation of the Netherlands, in document GHG-WG 2/2/1, expressed the view that the present definition of $V_{ref}$ was consistent with the definition of capacity and power of a vessel. However, the procedure for determination of the value of $V_{ref}$ had to be defined transparently and unambiguously, in such a way that the result could be verified in a practical manner. It was proposed to calculate $V_{ref}$ from data representing the final design, in which results of model tests are included. It was also proposed to include model tests at the deepest operational draft in the eventual model test programmes; and

2. The delegation of the Republic of Korea, in document GHG-WG 2/2/12, stated that the present definition for $V_{ref}$ in the denominator of the EEDI formula may lead to erroneous interpretation that the sea trial needs to be conducted “on deep water in the maximum design load condition” and proposed revising the formula.

2.35 The group noted that the final decision related to $V_{ref}$ would depend on the outcome of the debate on verification of the EEDI.

2.36 Noting that the proposal from Republic of Korea in document GHG-WG 2/2/12, paragraph 10, with regard to $V_{ref}$ was for verification purposes only, the group agreed that the proposal should incorporate draft guidelines for verification that would need to be developed.

**Carbon to CO₂ factors ($C_f$) to be used in the EEDI**

2.37 Under this sub-item the group considered document:

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<th>Relevant Parts</th>
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<tbody>
<tr>
<td>(paragraphs 5 – 10)</td>
<td>GHG-WG 2/2/17</td>
<td>Japan</td>
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1. The delegation of Japan, in document GHG-WG 2/2/17, underlined that while the present text of the Interim Guidelines refers to the 2006 IPCC Guidelines only, the IPCC Guidelines do not directly give the values for the conversion factors.
(C_i). Conversion factors to be used for EEDI calculation should be consistent with those for the EEOI, and the Interim Guidelines for EEDI should have a table clearly and directly showing the conversion factors on fuel types to ensure the user-friendliness; the same table should be used in the Guidelines for EEOI as well.

2.38 It was noted during the debate that the Carbon to CO_2 factors used the EEDI should be harmonized with the factors used in the EEOI.

2.39 The group agreed to the proposal by Japan (document GHG-WG 2/2/17) to include, in the EEDI guidelines, Carbon to CO_2 factors based on the 2006 IPCC guidelines. The group also agreed that the same Carbon factors shall be used for the purpose of the EEOI.

**Matters related to ice strengthening**

2.40 Under this sub-item the group considered the following documents:

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<thead>
<tr>
<th>Document</th>
<th>Description</th>
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<tbody>
<tr>
<td>GHG-WG 2/2/20</td>
<td>Canada, Estonia, Finland and Norway</td>
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.1 The co-sponsors, in document GHG-WG 2/2/20, provided background on ice class rules and presented the outcome of a pilot study using LRF data of 27,000 tankers to determine the \( f_i \) coefficients for power and the coefficient \( f_j \) for capacity with regard to ice strengthened ships for the attained EEDI.

2.41 During the ensuing debate the following points were highlighted:

.1 a significant share of new vessels and, in particular, tankers, were built to ice class and, therefore, there was a need to include ice strengthened ships within the scope of the EEDI;

.2 polar classes should also be taken into account; and

.3 correction factors may only be considered for the higher ice classes, not for all.

2.42 The group agreed to the methodology presented in the document GHG-WG 2/2/20 for determination of factors \( f_i \) and \( f_j \). The group noted the intention of the submitters of the document to provide concrete proposal for \( f_i \) and \( f_j \) to MEPC. Therefore, the group agreed to leave the paragraph for \( f_i \) and \( f_j \) unchanged (some editorial improvement was agreed and undertaken).

**Baselines for the EEDI**

2.43 Under this sub-item the group considered the following documents:

<table>
<thead>
<tr>
<th>Document</th>
<th>Description</th>
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<tbody>
<tr>
<td>GHG-WG 2/2/7</td>
<td>Denmark</td>
</tr>
<tr>
<td>GHG-WG 2/2/9</td>
<td>China</td>
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<tr>
<td>GHG-WG 2/2/18</td>
<td>Japan</td>
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<tr>
<td>GHG-WG 2/2/22</td>
<td>CESA</td>
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<table>
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<th>Document</th>
<th>Description</th>
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<tbody>
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<td></td>
<td>relevant parts (paragraphs 17 – 19)</td>
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The delegation of Denmark, in document GHG-WG 2/2/7, informed the group that recalculation of baseline values had been undertaken for: dry cargo carriers, tankers, gas tankers, containerships and ro-ro cargo ships based on the simplified (2.5% or 5%) definition of auxiliary engine power $P_{AE}$, capacity, the conversion factor between fuel consumption and the CO₂ emission, and the rated installed power for main engines agreed on at MEPC 58;

The delegation of China, in document GHG-WG 2/2/9, presented the outcome of a study showing significant differences from baseline values presented at MEPC 58 and advocated that further verification of the baseline calculations were needed, and that another mathematical model should be considered for container ships to reflect its characteristics accurately. The current baseline methodology would penalize CSR ships (Common Structural Rules) and principles of selecting samples and minimum number of samples should be established to determine the calculation method in a uniform and transparent manner;

Introducing document GHG-WG 2/2/18, the delegation of Japan provided technical considerations of the EEDI baselines, derived from data of existing ships, as an analytical basis for drawing appropriate baselines to make the EEDI requirements practical and enforceable; and

The observer delegation of CESA, in document GHG-WG 2/2/22, argued that the draft EEDI did not take into account the speed/power relation, which derives from the unavoidable wave resistance of surface vessels, and that it was not appropriate to use capacity as the only baseline regression parameter but that also speed and capacity should be used as input variables for the baseline.

The group exchanged views on the issues and it was highlighted that:

ships built in accordance with the Common Structural Rules (CSR) will have a higher lightship weight than ships built before such rules were applied;

the baselines are only used for comparison and the actual required reduction (x) will be the vital issue applying the EEDI;

the impacts of new IMO safety and environmental regulations may be taken into account when applying the EEDI to different ship types and sizes;

the scatter for most ship types, and in particular, for container vessels, were due to different speeds;

a common understanding of the baselines and their purposes was needed;

the baseline should be fixed when set to always be able to illustrate efficiency improvements; and

the latest available data should be used when setting the baseline.

Responding to questions of other delegations, the observer representative of IACS stated that potential negative effects on safety features were investigated but no significant impact was identified for the time being. However, IACS would continue to monitor these developments.
2.45 The group agreed:

.1 to keep the formula for baselines as agreed at MEPC 58 \((y = a \text{ capacity } ^c)\) because this formula was supported on the basis of statistics and mathematics;

.2 that the baselines would be calculated using data of ships built during the last 10-year period;

.3 that information and comments in document GHG-WG 2/2/22 (CESA) should be kept for further consideration; and

.4 that safety should not be compromised in seeking environmental protection.

2.46 The delegation of China reserved its position on the baselines to be included in the EEDI on the reasons provided in document GHG-WG 2/2/9. IMO needed to find the correct method before developing the concept further, otherwise problems would be encountered later. China advocated that speed should also be included in the baseline formula and that a high degree of correlation should be required.

Regulatory framework

2.47 Under this sub-item the group considered the following documents:

- relevant parts (paragraphs 25 – 26) GHG-WG 2/2/8 Sweden
- relevant parts (except paragraphs 8 – 9) GHG-WG 2/2/16 Japan

.1 The delegation of Sweden, in introducing document GHG-WG 2/2/8, underlined that prior to implementation of the EEDI it should be clearly defined at what stage of a new building project an attained index should apply. Since an authority approval based on results obtained during sea trials may impose an undesired margin of installed power, it was recommended that authority approval should be granted in due time prior to commencing steel cutting at the shipyard; and hence be based on results obtained from model tests or equivalent speed-power predictions performed by a renowned testing facility; and

.2 The delegation of Japan, in document GHG-WG 2/2/16, presented the elements necessary for the establishment of an EEDI scheme, focusing on the verification and certification process, and proposing text for the regulatory framework and skeleton draft guidelines on verification and certification of the EEDI.

2.48 The group noted annex 1 to document GHG-WG 2/2/16 with acknowledgement to Japan for its effort to improve editorially the draft proposed regulatory framework based on annex 1 to document GHG-WG 1/2/1. While noting the intention of Japan to submit another document on the regulatory framework to MEPC 59, the group noted that it would be useful to hold an informal exchange of views among interested delegations in this regard, in order for Japan to prepare such a submission.

2.49 The delegation of India made a statement as set out in annex 6.
Verification of the EEDI

2.50 Under this sub-item the group considered the following documents:

<table>
<thead>
<tr>
<th>Relevant Parts (Paragraphs 9 – 10)</th>
<th>Document</th>
<th>Country</th>
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<tbody>
<tr>
<td>GHG-WG 2/2/1</td>
<td></td>
<td>Netherlands</td>
</tr>
<tr>
<td>GHG-WG 2/2/14</td>
<td></td>
<td>Norway</td>
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<tr>
<td>GHG-WG 2/2/16</td>
<td></td>
<td>Japan</td>
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</table>

1. The delegation of the Netherlands, in introducing document GHG-WG 2/2/1, underlined that sea trials were often carried out in conditions that did not match the conditions prescribed by the Design Index. It was proposed to include model tests at the deepest operational draft in the eventual model test programmes;

2. The delegation of Norway, in document GHG-WG 2/2/14, summarized the verification options and advocated that verification should be based on sea trial measurement without mandatory plan approval. Norway also proposed that IMO should develop a framework for which ship performance could be verified based on sea trial measurements, not dissimilar in size and complexity from the NOx Technical. Significant time and resources would be needed to develop what may be termed IMO “EEDI Technical Code” and that this work should preferably start as soon as possible; and

3. The delegation of Japan, in document GHG-WG 2/2/16, emphasized that the establishment of a verification and certification scheme was essential to ensure reasonable accuracy of the Attained EEDI, which is the foundation for enforcement of the scheme and the credibility of the scheme itself. The attained EEDI should be verified in a transparent, consistent and fair manner.

2.51 The group exchanged views on the subject and the following was highlighted:

1. Verification of the EEDI would be needed under any regime also as part of trial calculations;

2. A definition of verification was needed to provide a common understanding; and

3. Clarification was needed in cases where a ship might not comply with the required index.

2.52 The group concurred with the chairman’s view that the verification process was a technical issue and would be one of the targets of trial calculations of the EEDI.

2.53 The majority of the delegations who spoke supported option 3 in document GHG-WG 2/2/14 (Norway).

2.54 The group agreed that the flow of the verification process shown in Figure 1 and the skeleton draft guidelines for verification of EEDI in annex 2 to document GHG-WG 2/2/16 (Japan) would be a good basis for further development of such guidelines with changes of terminology in order to avoid any reference to mandatory application.
2.55 The group acknowledged Japan and Norway for their intention to submit a more concrete proposal of draft guidelines for verification to MEPC 59 based on the concept of option 3 in GHG-WG 2/2/14 and the flow chart and skeleton in document GHG-WG 2/2/16.

2.56 The group also agreed to invite new submissions to facilitate work at MEPC 59.

**Statement by Greece**

2.57 The following statement was made by the delegation of Greece:

“This delegation keeps serious concerns regarding the proposal for the establishment of a procedure for verification and certification of EEDI by the Administrations as referred in documents GHG-WG 2/2/1 and GHG-WG 2/2/16. On the other hand we would support the relevant views expressed in document GHG-WG 2/2/14 submitted by Norway and in particular the suggested option 2 regarding verification based on sea trials measurements data without prior approval.

It is also our view that the verification of the factors used for the calculation of EEDI and its consequent certification should only be established after the completion of the relevant sea trials following construction of the vessel. (For example, after conducting inclining experiment for the determination of displacement and DWT, speed measurements for Vref record and maybe other sea trials measurements related to fuel consumption, waste heat recovery, etc.)

Therefore, any proposal related to the approval, verification or even certification by the Administration of the Index in a preliminary stage is considered inappropriate, for a number of reasons like the following:

1. It would rely on doubtable and non practically measurable data;
2. We can hardly recall any relative requirements under the existing IMO legal instruments enforcing preliminary verification or certification procedures by the Administration;
3. The performance of model tests prior to the commencement of the shipbuilding, a procedure which has been proposed by some delegations to be used as the basis for the preliminary verification and certification by the Administration, is not obligatory whatsoever under any statutory or class regulations; and
4. The undertaking or even the reduction of the shipbuilders or ship owners’ business risk, by the official preliminary approval or verification during the design stage, of parameters, like maximum speed or DWT, which are part of the building contract’s clauses, and the consequent liaison burden, does not lie within the scope of the Administration’s responsibilities or competences.”

**Statement by INTERFERRY**

2.58 The following statement was made by the observer representative of INTERFERRY also on behalf of ICS and CLIA (in reference to the discussion on submissions GHG-WG 2/2/14 by Norway and GHG-WG 2/2/16 by Japan:

“Thank you Mr. Chairman,
While recognizing that no discussion had yet taken place on the application of the EEDI, INTERFERRY, ICS and CLIA appreciated the discussion on how the EEDI could be verified after its implementation as an IMO instrument; this is a fundamental concern for the shipping industry.

Option 3 presented by Norway in submission 2/2/14 gained some support from the working group, but the industry sought some clarification on what was meant by the phrases “plan approval” and “sea trial verification”. The inter-relationship between these concepts was also questioned.

- Should plan approval be interpreted both as a signal to begin constructing the proposed design and an acceptance that the eventual energy efficiency of that design should be de facto accepted so that the ship can commence its service after its final construction?, or

- Should “sea trial verification” in addition to plan approval be interpreted as a second phase of approval, so that if the ship during sea trial, for any reason, does not meet its required EEDI, it would not be allowed to commence its service after its final construction?, or

- Should “sea trial verification” in addition to plan approval be utilized as a means to provide feedback to the plan approval process?

In order to be able to make the commitment of ordering a vessel, after the eventual implementation of the EEDI as an IMO instrument, it is of fundamental importance that the approval process should be clearly defined with no possibility for ambiguity.”

Draft interim Guidelines on the method of calculation of the EEDI

2.59 The group agreed with the draft interim Guidelines on the method of calculation of the EEDI for new ships as set out at annex 2.

3 REVIEW OF THE ENERGY EFFICIENCY OPERATIONAL INDEX

3.1 Under this agenda item the group considered documents GHG-WG 2/3 (RINA) on Monitoring of the Energy Efficiency Operational Index (EEOI); and GHG-WG 2/3/1 (Belgium) on Information on trials according to the Interim Guideline for Voluntary Ship CO₂ Emission Indexing. In addition, the group also considered part of document GHG-WG 2/4/2 (United States) addressing issues related to the EEOI.

3.2 The delegation of Belgium introduced document GHG-WG 2/3/1 providing the findings of trials on 43 ships of five ship categories by applying the Interim EEOI (MEPC/Circ.471). The group noted that the following corrections should be made in the document:

Page 4, paragraph 20, third line: 10.2 should read 24.7

Page 5, table 3, the second last line (Average) should read:

- 2nd column: 10.2 should read 24.7
- 3rd column: 6.3 should read 18.8
- 4th column: 10.8 should read 21.5
3.3 The group noted that there was a strong variation in the results of the EEOI calculations as a function of the following variables:

.1 fuel consumption during port time is yet another parameter causing a strong variation in the index;

.2 cargo space utilization and length of ballast leg also influence the index; and

.3 a definition for “voyage”, now absent in MEPC/Circ.471 should be developed.

3.4 The group noted also the proposal to split the EEOI in three “sub-indices”, namely: Cargo EEOI, Ballast EEOI and Port EEOI, thus providing a better understanding and transparency on the causes of variation of EEOI calculations.

3.5 The observer delegation from RINA indicated in its document GHG-WG 2/3 that the index should be calculated on a voyage basis as use of a rolling average masked any variation between voyages (legs) and would also mask any small reduction due to efficiency improvements. It also advocated the use of speed through the water as opposed to speed over the ground as the effect of current may again mask any efficiency, or inefficiency, gained in the latter case.

3.6 In that respect, the group agreed that the EEOI is an indicator of actual energy efficiency (CO$_2$ emission) during operation of the ship, but does not indicate any ship-specific performance. Therefore, the group did not agree with RINA’S proposed method of calculation in document GHG-WG 2/3.

3.7 The delegation of the United States, in part of document GHG-WG 2/4/2, expressed the view that the EEOI provides key benefits as a tool for assessing efficiency of existing ships and recommended that the maximum period for rolling average should be two years. In addition, certain ships could be excluded from the use of EEOI, such as, inter alia, those which are not required to obtain an IAPP certificate, search and rescue and privately owned recreational craft.

3.8 In the ensuing discussion the following points were made:

.1 in certain cases, the rolling average as a means to calculate the EEOI, may not be the best tool to provide a ship operator with adequate information as to efficiency as some ships and trades will require to develop a different methodology;

.2 the EEOI should be a straightforward, uncomplicated and reliable tool for existing ships and should be voluntary in nature;

.3 cargo mass, as opposed to volume, is the adequate capacity unit for many types of vessels; and

.4 the EEOI should be as flexible as possible and best results would be obtained if ship operators were to decide which parameters to choose in its calculation.
3.9 Following the debate, the group agreed on the proposal to change the term “Index” to “Indicator” in the EEOI title.

3.10 The Chairman, as coordinator of the correspondence group on EEOI, having shown a draft revised EEOI to the group, reported on the progress of the correspondence group and, in particular, highlighted the following discussion points within the correspondence group:

.1 capacity for container ships, e.g., DWT or TEU (box number);
.2 capacity for bulk cargo carriers, e.g., DWT or volume (m$^3$);
.3 method to deal with ballast voyages; and
.4 rolling average.

3.11 The group recalled that the development of the EEOI was initiated by Assembly resolution A.963(23) whereby, in operative paragraph 1(b), the MEPC was requested to develop a methodology to describe the GHG efficiency of a ship in terms of a GHG emission index.

3.12 In concluding, the group agreed that the correspondence group should take into account the comments made at the current meeting, as set out at annex 3, for preparation of a draft revised EEOI for submission to MEPC 59.

4 MANAGEMENT TOOL ON ENERGY EFFICIENCY FOR SHIPS

4.1 Under this agenda item the group considered documents GHG-WG 2/4 (Japan); GHG-WG 2/4/1 (ICS et al); and GHG-WG 2/4/2 (United States).

4.2 The delegation of Japan, in document GHG-WG 2/4, provided a possible framework for the establishment of a Ship Energy Management Plan (SEMP) that could be implemented following the methodology set out in the ISM Code. Shipping companies would have the discretion to select the most suitable package of operational measures, taking into account specific conditions of their ships and operation. The mechanism for the implementation of a SEMP would have the following elements:

.1 measures for improving efficiency;
.2 monitoring through the EEOI; and
.3 self-evaluation and development of an improvement plan.

4.3 The co-sponsors, in document GHG-WG 2/4/1, further developed and revised the SEMP concept where a wide range of potential efficiency measures were included. However, not all measures could be applied to all ships, or even to the same ship under different operating conditions, as some are mutually exclusive and others depend upon variable factors such as the trading pattern and operational constraints of specific cargoes and trades.

4.4 In the view of the co-sponsors, a guidance document to indicate factors to be considered in developing a SEMP should be developed taking into account that its contents and the subject areas included should be indicative, not prescriptive. Companies would need to develop ship-specific plans to accommodate the particular circumstances of the operation of their ships.
and trading patterns. The EEOI could form part of the SEMP which should not be considered as a tool for port State control purposes.

4.5 The United States, in document GHG-WG 2/4/2, proposed a framework to improve the energy efficiency of existing ships through the SEMP, consisting of three elements: calculation of the EEOI; the SEMP as the primary tool to ensure that each vessel is working to improve its energy efficiency; and a voluntary reporting of the EEOI and other measures of efficiency improvements to incentivize action and facilitate supply chain improvements. The United States further noted the significant emissions reductions and cost savings possible through efficiency improvements in the suggested framework.

4.6 Following discussions, the group agreed that the ship energy management plan (SEMP) should be established through the establishment of voluntary basis.

4.7 The Chairman presented a proposed framework for the SEMP concept, as set out at annex 4, outlining that a SEMP should be established in four steps; planning, implementation, monitoring and self-evaluation and improvement. The group agreed with the concept and invited interested Member Governments and observers to submit draft SEMP proposals, based on the concept, to MEPC 59.

4.8 The group further agreed to retain the annex of document GHG-WG 2/4/1 and attach it as annex 5 to this report, for further consideration at MEPC 59.

4.9 The delegation of China underlined that, due to the voluntary character of the SEMP, all references to ISM in the draft Guidance on the Development of a Ship Efficiency Management Plan should be removed to avoid any confusion of its mandatory application.

5 GUIDANCE ON BEST PRACTICES AND OTHER VOLUNTARY OPERATIONAL MEASURES

5.1 The group noted that no documents had been submitted under this agenda item.

5.2 The group recognized that the guidance on best practices for fuel-efficient operation of ships as contained in annex 3 of document MEPC 58/WP.8 can be used as one of the tools under the ship energy management plan.

5.3 The group recognized also that the proposed draft guidance on the development of a ship efficiency management plan set out in the annex of document GHG-WG 2/4/1 contains, in paragraph 1.4, guidance on best practices which are similar to those in annex 3 to MEPC 58/WP.8.

5.4 In concluding, the group agreed that the guidance on best practices referred to above may form the basis for further development at MEPC 59 and recommend to the Committee that the working group to be established at that session should be tasked to finalize it within the framework of the SEMP.

6 POSSIBLE IMPACTS ON THE SHIPPING SECTOR FROM THE MEASURES ENVISIONED

6.1 The group noting that no documents had been submitted under this agenda item, was unable to reach any conclusion. However, the group agreed that this subject may be important when measures currently under discussion for reduction of GHG emissions from ships are
finalized and, therefore, agreed to invite the MEPC to retain this item on its agenda for further consideration.

6.2 The group agreed to invite interested Member Governments and observers to submit comments in this regard to MEPC 59.

7 ANY OTHER BUSINESS

7.1 The group agreed to a proposal by the Chairman to invite the Committee to give a clear instruction to the working group to be established at MEPC 59 to prepare a draft MEPC resolution and/or circular for dissemination of the guidelines on the EEDI, EEOI and SEMP that may be agreed by the Committee.

8 ACTION REQUESTED OF THE COMMITTEE

8.1 The Marine Environment Protection Committee is invited to:

1. consider, toward finalization, the draft guidelines for Energy Efficiency Design Index (EEDI) as set out in annex 2 and consider preparation of an MEPC resolution or an MEPC Circular to implement the EEDI on a voluntary basis;

2. note the group’s view on the application of the EEDI as set out in annex 2 to certain types of ships (e.g., passenger ships and ships having diesel-electric, turbine or hybrid propulsion systems) (paragraph 2.11 and annex 2);

3. note the group’s view on the baseline issues (paragraphs 2.43 to 2.46);

4. note the intention of the members regarding the verification process on the EEDI (paragraphs 2.51 to 2.57);

5. agree with the change of the title of the “Energy Efficiency Operational Index” to “Energy Efficiency Operational Indicator” (paragraph 3.9);

6. note that the content of annex 3 was sent to the correspondence group for Energy Efficiency Operational Index (EEOI) (paragraph 3.12 and annex 3);

7. note the proposed outline of a Ship Efficiency Management Plan (SEMP) in annex 4 and consider the proposed concept of the SEMP, as set out in annex 5 (paragraphs 4.1 to 4.8 and annexes 4 and 5);

8. note the group’s agreement on the best practices for fuel-efficient operation of ships (paragraphs 5.1 to 5.4) and consider the recommendation of the group in paragraph 5.4;

9. note the group’s view on the possible impacts on the shipping sectors from applying the measures envisaged (paragraphs 6.1 to 6.2); and

10. approve the report in general.

***
ANNEX 1

GENERAL STATEMENT BY THE DELEGATION OF CHINA

Dear Mr. Chairman,

Thank you and the IMO Secretariat for the efforts to prepare this second Intersessional Working Group meeting. The Chinese delegation is willing to cooperate with you and the other delegations present, to achieve the tasks set out in the Terms of Reference mandated by MEPC 58, China would therefore like to emphasise the following:

Firstly, the energy efficiency design index (EEDI) is the core element in ship greenhouse gas emission reduction; it is also the top priority issue of this meeting. All members of IMO are very much concerned with the issue and some have submitted proposals to GHG-WG 2, we all hope that the meeting can fully discuss and consider these submissions.

Secondly, the EEDI is a complicated technical issue, which is time consuming and needs more in-depth study, as well as further exchange of opinions; we must be patient with technical and technological matter. I believe that IMO should work for its function for shipping, IMO is not requested to work neither for the Bali Action Plan of UNFCCC nor the so called the “Roadmap to Copenhagen”.

Thirdly, the opinions of developing countries should be respected, as the developing countries are in a weak position technologically. China hopes that the weak voices from the developing world will be given the attention they deserve.

Fourthly, as mentioned by the Director of the Marine Environment Division, that IMO and MEPC 59 will heavily rely on the outcome of this intersessional working group meeting, for its ambitious strategy in contribution to the COP 15 of UNFCCC, I would like to point out that IMO is generally a technical organization, a specialised agency under the United Nations framework. I am very reluctant to support that IMO should go beyond its functional limitation.

Finally, as regard the agenda, the GHG-WG 2 report to MEPC 59 is one of the possible items of the meeting. We need to have a report of the meeting; nevertheless, we should not sacrifice or ignore its substantial contents, which must be fully discussed. As a Chinese proverb says, “over speeding will not help you approaching your destination”.

Thank you, Mr. Chairman.

***
1. Definitions

For the purpose of these guidelines, the following definitions should apply:

| .1 | Passenger ship | a ship which carries more than 12 passengers as defined in SOLAS chapter 1, regulation 2 |
| .2 | Dry cargo carrier | a ship which is constructed generally with single deck, top-side tanks and hopper tanks in cargo spaces, and it is intended primarily to carry dry cargo in bulk, and includes such types as ore carriers and combination carriers, as defined in SOLAS chapter IX, regulation 1 |
| .3 | Gas tanker | a gas carrier as defined in SOLAS chapter II-1, regulation 3 |
| .4 | Tanker | an oil tanker as defined in MARPOL Annex 1, regulation 1 or chemical tanker and a NLS tanker as defined in MARPOL Annex II, regulation 1 |
| .5 | Container ship | a ship designed exclusively for the carriage of containers in holds and on deck |
| .6 | Ro-ro cargo ship | a ship designed and constructed for the carriage of vehicles, and cargo in pallet form or on containers, and loaded/unloaded by wheeled vehicles |
| .7 | General cargo ship | a ship with a multi-deck or single deck hull designed primarily for the carriage of general cargo |
| .8 | Ro-ro passenger ship | a passenger ship as defined in SOLAS chapter II-1, Part A, regulation 2.23 |

Ships falling within more than one of the ship types should be considered as being the ship type with the lower baseline.

2. Energy Efficiency Design Index (EEDI)

The attained new ship Energy Efficiency Design Index (EEDI) is a measure of ships CO₂ efficiency and calculated by the following formula:
\[
\left( \prod_{i=1}^{M} f_i \right) \left( \sum_{j=1}^{n_{MEi}} P_{MEi} C_{SFC MEi} \right) + \left( \prod_{i=1}^{M} f_i \right) \left( \sum_{j=1}^{n_{AEi}} P_{AEi} C_{SFC AEi} \right) + \left( \sum_{i=1}^{n_{PTi}} f_i P_{PTi} \right) \left( \sum_{i=1}^{n_{PTi}} f_i P_{PTi} \right) \left( C_{SFC AEi} \right) = \left( \sum_{i=1}^{n_{PTi}} f_i P_{PTi} \right) \left( C_{SFC MEi} \right) \\
\]

\[f_i \cdot \text{Capacity} \cdot V_{ref} \cdot f_w\]

* If part of the Normal Maximum Sea Load is provided by shaft generators, \( SFC_{ME} \) may – for that part of the power - be used instead of \( SFC_{AE} \)

**Note:** This formula may not be able to apply to diesel-electric propulsion, turbine propulsion or hybrid propulsion system.

Where:

1. \( C_F \) is a non-dimensional conversion factor between fuel consumption measured in g and CO₂ emission also measured in g based on carbon content. The subscripts \( MEi \) and \( AEi \) refer to the main and auxiliary engine(s) respectively. \( C_F \) corresponds to the fuel used when determining \( SFC \) listed in the applicable EIAPP Certificate. The value \( C_F \) of is as follows:

<table>
<thead>
<tr>
<th>Type of fuel</th>
<th>Reference</th>
<th>( C_F ) (t-CO₂ / t-Fuel)</th>
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<tr>
<td>1. Diesel/Gas Oil</td>
<td>ISO 8217 Grades DMX through DMC</td>
<td>3.186¹</td>
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<tr>
<td>2. Light Fuel Oil (LFO)</td>
<td>ISO 8217 Grades RMA through RMD</td>
<td>3.151</td>
</tr>
<tr>
<td>3. Heavy Fuel Oil (HFO)</td>
<td>ISO 8217 Grades RME through RMK</td>
<td>3.114</td>
</tr>
<tr>
<td>4. Liquid Petrol Gas (LPG)</td>
<td>2006 IPCC guidelines Table 1.2 and 3.5.2</td>
<td>2.985¹</td>
</tr>
<tr>
<td>5. Natural Gas</td>
<td>2006 IPCC guidelines Table 1.2 and 3.5.2</td>
<td>2.693¹</td>
</tr>
</tbody>
</table>

¹ Conversion factors for Diesel/Gas Oil, LPG and Natural Gas are calculated by default value of those fuels in Table 1.2 (Default Net Calorific Values (NCVs) and Lower and Upper Limits of the 95% Confidence Intervals) and Table 3.5.2 (CO₂ Emission Factors) in Volume 2 of the 2006 IPCC Guidelines. LFO and HFO are classified in one category as “Residual Fuel Oil” in the 2006 IPCC Guidelines.

2. \( V_{ref} \) is the ship speed, measured in nautical miles per hour (knot), on deep water in the maximum design load condition (Capacity) as defined in paragraph 3 at the shaft power of the engine(s) as defined in paragraph 5 and assuming the weather is calm with no wind and no waves. The maximum design load condition shall be defined by the deepest draught with its associated trim, at which the ship is allowed to operate. This condition is obtained from the stability booklet approved by the Administration.

3. Capacity is defined as follows:

3.1 For dry cargo carriers, tankers, gas tankers, container ships, ro-ro cargo and general cargo ships, deadweight should be used as Capacity.
.3.2 For passenger ships and ro-ro passenger ships, gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, Annex I, regulation 3 should be used *Capacity*.

.4 *Deadweight* means the difference in tones between the displacement of a ship in water of relative density of 1,025 kg/m³ at the deepest operational draught and the lightweight of the ship.

.5 *P* is the power of the main and auxiliary engines, measured in kW. The subscripts "ME" and "AE" refer to the main and auxiliary engine(s), respectively. The summation on *i* is for all engines with the number of engines (*nME*). (See the diagram in Appendix)

.5.1 *P*<sub>ME(i)</sub> is 75% of the rated installed power (MCR) for each main engine (*i*) deducted any installed shaft generator(s):

\[ P_{\text{ME}(i)} = 0.75 \times (\text{MCR}_{\text{ME}(i)} - P_{\text{PTO}(i)}) \]

The following figure gives guidance for determination of *P*<sub>ME(i)</sub>:

.5.2 *P*<sub>PTO(i)</sub> is 75% output of each shaft generator installed divided by the relevant efficiency of that shaft generator

.5.3 *P*<sub>PTM(i)</sub> is 75% of the rated power consumption of each shaft motor divided by the weighted averaged efficiency of the generator(s)
In case of combined PTI/PTO the normal operational mode at sea will determine which of these to be used in the calculation.

.5.4 \( P_{\text{eff}(i)} \) is [75% of] the main engine power reduction due to innovative mechanical energy efficient technology

Mechanical recovered waste energy directly coupled to shafts need not be measured.

.5.5 \( P_{\text{AE}\text{eff}(i)} \) is the auxiliary power reduction due to innovative electrical energy efficient technology measured at \( P_{\text{ME}(i)} \)

.5.6 \( P_{\text{AE}} \) is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery/systems and accommodation, e.g., main engine pumps, navigational systems and equipment and living on board, but excluding the power not for propulsion machinery/systems, e.g., thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, e.g., reefer and cargo hold fans, in the condition where the ship engaged in voyage at the speed \( (V_{\text{ref}}) \) under the design loading condition of \textit{Capacity}.

.1 For cargo ships with a main engine power of 10000 kW or above, \( P_{\text{AE}} \) is defined as:

\[
P_{\text{AE}(\text{MCRM}>10000\text{KW})} = \left( 0.025 \times \sum_{i=1}^{n_{\text{ME}}} \frac{MCR_{\text{ME}}}{1} \right) + 250
\]

.2 For cargo ships with a main engine power below 10000 kW, \( P_{\text{AE}} \) is defined as:

\[
P_{\text{AE}(\text{MCRM}<10000\text{KW})} = 0.05 \times \sum_{i=1}^{n_{\text{ME}}} \frac{MCR_{\text{ME}}}{1}
\]

.3 For ship types where \( P_{\text{AE}} \) value is calculated by .1 or .2 above is significantly different from the total power used at normal seagoing, e.g., in cases of passenger ships, \( P_{\text{AE}} \) should be estimated by the consumed electric power (excluding propulsion) at normal sea going, to be given in the electric power table\(^3\), divided by the conversion factor (0.9) from diesel engine power to electric power.

.6 \( V_{\text{ref}}, \text{Capacity} \) and \( P \) should be consistent with each other.

.7 \textit{SFC} is the certified specific fuel consumption, measured in g/kWh, of the engines. The subscripts \( \text{ME}(i) \) and \( \text{AE}(i) \) refer to the main and auxiliary engine(s), respectively. For engines certified to the E2 or E3 duty cycles of the NOx Technical Code 2008 the engine Specific Fuel Consumption (\( SFC_{\text{ME}(i)} \)) is that recorded on the EIAPP

\(^3\text{Note: The electric power table is often verified and approved by the Administration/ Recognized Organizations because it can be the documentation relating to the SOLAS Chapter II-1 Part D Regulation 40.1.1. The electric power table shows the generator load summary in kW and lists up generators in service by each condition of ship operation, e.g., “normal sea going”, etc.}\)
Certificate(s) at the engine(s) 75% of MCR power or torque rating. For engines certified to the D2 or C1 duty cycles of the NO\textsubscript{x} Technical Code 2008 the engine Specific Fuel Consumption ($SFC_{AE(i)}$) is that recorded on the EIAPP Certificate(s) at the engine(s) 50% of MCR power or torque rating.

$SFC_{AE}$ is the weighted average among $SFC_{AE(i)}$ of the respective engines $i$.

For those engines which do not have EIAPP Certificate because its power is below 130 kW, $SFC$ specified by the manufacturer and endorsed by competent an authority should be used.

.8 $f_j$ are correction to account for ship specific design elements.

The $f_j$ for ice-classed ships is determined by the standard $f_j$ “table/curve” which is to be contained the Guidelines.

[$f_j$ for ice-classed ships will be provided at MEPC 59]

.9 $f_W$ is an non-dimensional coefficient indicating the decrease of speed in representative sea conditions of wave height, wave frequency and wind speed (e.g., Baufort Scale 6), and should be determined as follows:

.9.1 It can be determined by conducting the ship-specific simulation of its performance at representative sea conditions. The simulation methodology should be prescribed in the Guidelines developed by the Organization and the method and outcome for an individual ship shall be verified by the Administration or an organization recognized by the Administration.

.9.2 In case that the simulation is not conducted, $f_W$ value should be taken from the “Standard $f_W$” table/curve. A “Standard $f_W$” table/curve, which is to be contained in the Guidelines, is given by ship type (the same ship as the “baseline” below), and expressed in a function of the parameter of Capacity (e.g., DWT). The “Standard $f_W$” table/curve is to be determined by conservative approach, i.e. based on data of actual speed reduction of as many existing ships as possible under representative sea conditions.

.9.3 $f_W$ should be taken as one (1.0) until the Guidelines for the ship-specific simulation (paragraph .9.1) or $f_W$ table/curve (paragraph .9.2) becomes available.

.10 $f_{eff(i)}$ is the availability factor of each innovative energy efficiency technology. $f_{eff(i)}$ for waste energy recovery system should be one (1.0).

.11 $f_i$ is the capacity factor for any technical/regulatory limitation on capacity, and can be assumed one (1.0) if no necessity of the factor is granted.

[$f_i$ for ice-classed ships will be provided at MEPC 59].
Appendix

A Generic and Simplified Marine power Plant

Note 1: Mechanical recovered waste energy directly coupled to shafts need not be measured.

Note 2: In case of combined PTI/PTO the normal operational mode at sea will determine which of these to be used in the calculation.

***
ANNEX 3

RECOMMENDATION TO THE CORRESPONDENCE GROUP ON
REVISION OF THE EEOI (MEPC/CIRC.471)

General

1 Because the EEOI may be used by a wide variety of operators and other parties concerned, the guidelines on the EEOI should have certain flexibility.

Specific comments

2 Rolling average would give useful data for certain types of ships and operations and, therefore, should be kept.

3 Recognizing that the EEOI would be used as a monitoring tool for ship energy management, the following analysis should be possible using the EEOI:

   .1 relative utilization of cargo space;
   .2 relative consumption of fuel during ballast voyage;
   .3 efficiency of ship (engine condition, hull and propeller fouling, etc.);
   .4 variation in speed;
   .5 weather and currents;
   .6 errors in measurement and registration; and
   .7 port condition.

4 It should be possible to differentiate the EEOI for cargo voyage, ballast voyage and at port (e.g., cargo EEOI, Ballast EEOI and Port EEOI).

5 A definition for “voyage” should be developed.

6 Carbon factors should be harmonized with those in EEDI.

***
ANNEX 4

CONCEPT OF SHIP ENERGY MANAGEMENT PLAN (SEMP)

The SEMP should be developed by the ship operator or any other party concerned, e.g., charterer, for their own purpose to manage their fleet to improve the energy efficiency through the following steps/procedures.

1 Planning

Guidance on best practices on operational procedures to improve energy efficiency can be used. It is important to establish clear and measurable goals.

2 Implementation

The method for implementing the Plan in every ship of the fleet should be developed. Raising awareness of the seafarers on board is also a key element.

3 Monitoring

Energy efficiency should be monitored quantitatively. This should be done by an established method, preferably by an international standard.

4 Self evaluation and improvement

Procedures for self-evaluation of energy efficiency using data obtained by monitoring and for improvement of energy efficiency based on the results of the self-evaluation toward the determined goal should be established.

***
# ANNEX 5

**DRAFT GUIDANCE ON THE DEVELOPMENT OF A SHIP EFFICIENCY MANAGEMENT PLAN (SEMP)**

## CONTENTS

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INTRODUCTION

There are around 70,000 ships engaged in international trade and this unique industry carries 90% of world trade. Sea transport has a justifiable image of conducting its operations in a manner that creates remarkably little impact on the global environment. Compliance with the MARPOL Convention and other IMO instruments and the actions that many companies take beyond the mandatory requirements serve to further limit the impact. It is nevertheless the case that efficiencies can be found to reduce fuel consumption and to produce directly related reductions in CO₂ emissions for individual ships. While the yield of individual measures may be small, the collective effect across the entire fleet will be significant.

The price of fuel has been described, with justification, as an efficiency driver greater than any legislation and in response many owners and operators are concentrating considerable effort on finding more and more innovative ways to reduce fuel consumption and to improve efficiency across the supply chain.

In global terms it should be recognised that operational efficiencies delivered by a large number of ship operators will make an invaluable contribution to reducing global carbon emissions.

Provisions already exist in the ISM Code for owners and operators to monitor environmental performance and to establish a programme for continuous improvement. A Ship Efficiency Management Plan is simply an environmental procedure, which could be included alongside existing ISM requirements. It provides a possible approach for monitoring ship and fleet efficiency performance over time and some options to be considered when seeking to optimise the performance of the ship.
Part 1 – SEMP as part of the Company Environmental Management Plan

1.1 GENERAL

1.1.1 In the context of this document, the impact of the SEMP within the company environmental management plan is simply a revision of existing plans and procedures already established within a company in the form of the “Safety and Environmental Protection Policy” and the “Development of Plans for Shipboard Operations” under the relevant provisions of the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code).

1.1.2 Many companies will already have an environmental management system (EMS) in place under ISM and/or ISO14001 which contain procedures for selecting the best measures for particular vessels and then setting objectives for the measurement of relevant parameters, along with relevant control and feedback features. Monitoring of operational environmental efficiency should therefore be treated as an integral element of broader company management systems.

1.1.3 This document provides guidance for the development of a SEMP that should be adjusted to the characteristics and needs of individual companies and ships. The ship efficiency management plan as outlined in part 2 of this document is intended to be a management tool to assist a company in managing the ongoing environmental performance of its vessels and as such, it is recommended that a company develops procedures for implementing the plan in a manner which limits any onboard administrative burden to the minimum necessary.

1.2 APPLICATION

1.2.1 It is likely that company environmental management plans will cover the areas listed below. As noted above, many of these areas will already be considered under existing procedures and in addition, the format and content of such plans will need to be tailored to specific company and vessel needs, appropriate to the vessel types and trading patterns.

1 General
2 Definitions
3 Environmental considerations
4 Legal considerations
  4.1 International
  4.2 Regional
  4.3 National
5 Company efficiency management policy
6 Objectives and targets
7 Efficiency measures and options
8 Operational control and monitoring (reference to and explanation of the Operational Indicator)
9 Measuring and recording – development of ship board plans (connected with Part 2)
10 Training and awareness
11 Company verification and control
12 Certification, verification and control
1.3 OPERATIONAL INDICATOR

1.3.1 Monitoring of efficiency gains by use of a procedure based on the principles in the IMO Operational Indicator but developed to suit the individual company and ship should be implemented along with the SEMP.

1.3.2 It should be noted that, in order to avoid unnecessary administrative burdens on ships’ staff, monitoring should be carried out as far as possible by shore staff, utilising data obtained from existing required records such as the official and engineering logbooks and oil record books etc. Additional data could be obtained during internal audits under ISM, routine visits by superintendents, etc.

1.4 GUIDANCE ON BEST PRACTICES FOR FUEL-EFFICIENT OPERATION OF SHIPS

1.4.1 The search for efficiency across the entire transport chain takes responsibility beyond what can be delivered by the owner/operator alone. A list of all the possible stakeholders in the efficiency of a single voyage is long; obvious parties are designers, shipyards and engine manufacturers for the characteristics of the ship, and charterers, ports and vessel traffic management services etc., for the specific voyage. All involved parties should consider the inclusion of efficiency measures in their operations both individually and collectively.

Fuel Efficient Operations

Improved voyage planning

1.4.2 The optimum route and improved efficiency can be achieved through the careful planning and execution of voyages. Thorough voyage planning needs time, but a number of different software tools are available for planning purposes.

1.4.3 IMO-Resolution A.893(21) (25 November 1999) on voyage planning provides essential guidance for the ship’s crew and voyage planners.

Weather routeing

1.4.4 Weather routeing has a high potential for efficiency savings on specific routes. It is commercially available for all types of ship and for many trade areas. Significant savings can be achieved, but conversely weather routeing may also increase fuel consumption for a given voyage.

Just in time

1.4.5 Good early communication with the next port should be an aim in order to give maximum notice of berth availability and facilitate the use of optimum speed where port operational procedures support this approach.

1.4.6 Optimized port operation could involve a change in procedures involving different handling arrangements in ports. Port authorities should be encouraged to maximise efficiency and minimise delay.
**Speed optimization**

1.4.7 Speed optimisation can produce significant savings. However, optimum speed means the speed at which the fuel used per tonne mile is at a minimum level for that voyage. It does not mean minimum speed; in fact sailing at less than optimum speed will consume more fuel rather than less. Reference should be made to the engine manufacturer’s power/consumption curve and the ship’s propeller curve. Possible adverse consequences of slow speed operation may include increased vibration and sooting and these should be taken into account.

1.4.8 As part of the speed optimisation process, due account may need to be taken of the need to coordinate arrival times with the availability of loading/discharge berths etc. The number of ships engaged in a particular trade route may need to be taken into account when considering speed optimisation.

1.4.9 A gradual increase in speed when leaving a port or estuary whilst keeping the engine load within certain limits may help to reduce fuel consumption.

1.4.10 It is recognised that under many charter parties the speed of the vessel is determined by the charterer and not the operator. Efforts should be made when agreeing charter party terms to encourage the ship to operate at optimum speed in order to minimise CO₂ emissions.

**Optimized shaft power**

1.4.11 Operation at constant shaft RPM can be more efficient than continuously adjusting speed through engine power (see 1.4.7). The use of automated engine management systems to control speed rather than relying on human intervention may be beneficial.

**Optimized ship handling**

**Optimum trim**

1.4.12 Most ships are designed to carry a designated amount of cargo at a certain speed for a certain fuel consumption. This implies the specification of set trim conditions. Loaded or unloaded, trim has a significant influence on the resistance of the ship through the water and optimising trim can deliver significant fuel savings. For any given draft there is a trim condition that gives minimum resistance. In some ships it is possible to assess optimum trim conditions for fuel efficiency continuously throughout the voyage. Design or safety factors may preclude full use of trim optimisation.

**Optimum ballast**

1.4.13 Ballast should be adjusted taking into consideration the requirements to meet optimum trim and steering conditions and optimum ballast conditions achieved through good cargo planning for both dry cargo ships and liquid cargo ships.

1.4.14 When determining the optimum ballast conditions, the limits, conditions and ballast management arrangements set out in the ship’s Ballast Water Management Plan are to be observed for that ship.
1.4.15 Ballast conditions have a significant impact on steering conditions and autopilot settings and it needs to be noted that less ballast water does not necessarily mean the highest efficiency.

**Optimum propeller and propeller inflow considerations**

1.4.16 Selection of the propeller is normally determined at the design and construction stage of a ship’s life but new developments in propeller design have made it possible for retro-fitting of later designs to deliver greater fuel economy. Whilst it is certainly for consideration, the propeller is but one part of the propulsion train and a change of propeller in isolation may have no effect on efficiency and may even increase fuel consumption.

1.4.17 Improvements to the water inflow to the propeller using arrangements such as fins and/or nozzles could increase propulsive efficiency power and hence reduce fuel consumption.

**Optimum use of rudder and heading control systems (autopilots)**

1.4.18 There have been large improvements in automated heading and steering control systems technology. Whilst originally developed to make the bridge team more effective, modern autopilots can achieve much more. An integrated Navigation and Command System can achieve significant fuel savings by simply reducing the distance sailed “off track”. The principle is simple; better course control through less frequent and smaller corrections will minimise losses due to rudder resistance. Retrofitting of a more efficient autopilot to existing ships could be considered.

1.4.19 During approaches to ports and pilot stations the autopilot cannot always be used efficiently as the rudder has to respond quickly to given commands. Furthermore at certain stage of the voyage it may have to be de-activated or very carefully adjusted, i.e. heavy weather and approaches to ports.

1.4.20 Consideration may be given to the retrofitting of improved rudder blade design (e.g., ‘twist-flow’ rudder).

**Hull maintenance**

1.4.21 Docking intervals should be integrated with ship operator’s ongoing assessment of ship performance. Hull resistance can be optimized by new-technology coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.

1.4.22 Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognised and facilitated by port States.

1.4.23 Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.

1.4.24 Generally, the smoother the hull, the better the fuel efficiency.
Propulsion system

1.4.25 Marine diesel engines have a very high thermal efficiency (~50%). This excellent performance is only exceeded by fuel cell technology with an average thermal efficiency of 60%. This is due to the systematic minimisation of heat and mechanical loss. In particular, the new breed of electronic controlled engines can provide efficiency gains. However, specific training for relevant staff may need to be considered to maximise the benefits.

Propulsion system maintenance

1.4.26 Maintenance in accordance with manufacturers’ instructions in the company’s planned maintenance schedule will also maintain efficiency. The use of engine condition monitoring can be a useful tool to maintain high efficiency.

1.4.27 Additional means to improve engine efficiency might include:

- Use of fuel additives
- Adjustment of Cylinder lubrication oil consumption
- Valve improvements
- Torque analysis
- Automated engine monitoring systems

Waste heat recovery

1.4.28 Waste heat recovery is now a commercially available technology for some ships. Waste heat recovery systems use thermal heat losses from the exhaust gas for either electricity generation or additional propulsion with a shaft motor.

1.4.29 It may not be possible to retrofit such systems into existing ships. However, they may be a beneficial option for new ships. Shipbuilders should be encouraged to incorporate new technology into their designs.

Improved fleet management

1.4.30 Better utilization of fleet capacity can often be achieved by improvements in fleet planning. For example, it may be possible to avoid or reduce long ballast voyages through improved fleet planning. There is opportunity here for charterers to promote efficiency. This can be closely related to the concept of “just in time” arrivals.

1.4.31 Efficiency, reliability and maintenance-oriented data sharing within a company can be used to promote best practice among ships within a company and should be actively encouraged.

Improved cargo handling

1.4.32 Cargo handling is in most cases under the control of the port and optimum solutions matched to ship and port requirements should be explored.
Energy management

1.4.33 A review of electrical services on board can reveal the potential for unexpected efficiency gains. However care should be taken to avoid the creation of new safety hazards when turning off electrical services (e.g., lighting). Thermal insulation is an obvious means of saving energy. Also see comment below on shore power.

1.4.34 Optimisation of reefer container stowage locations may be beneficial in reducing the effect of heat transfer from compressor units. This might be combined as appropriate with cargo tank heating, ventilation etc. The use of water-cooled reefer plant with lower energy consumption might also be considered.

Fuel Type

1.4.35 Use of emerging alternative fuels may be considered as a CO₂ reduction method but availability will often determine the applicability.

Other measures

1.4.36 Development of computer software for the calculation of fuel consumption, for the establishment of an emissions ‘footprint’, to optimize operations, and the establishment of goals for improvement and tracking of progress may be considered.

1.4.37 Renewable energy sources, such as wind, solar (or Photovoltaic) cell technology, have improved enormously in the recent years and should be considered for on board application.

1.4.38 In some ports shore power may be available for some ships but this is generally aimed at improving air quality in the port area. If the shore-based power source is carbon efficient, there may be a net efficiency benefit. Ships may consider using on-shore power if available.

1.4.39 Even wind assisted propulsion may be worthy of consideration.

1.4.40 Efforts could be made to source fuel of improved quality in order to minimise the amount of fuel required to provide a given power output.

Compatibility of measures

1.4.41 This document indicates a wide variety of possibilities for CO₂ emission reduction for the existing fleet. While there are many options available, they are not cumulative, are often area and trade dependent and likely to require the agreement and support of a number of different stakeholders if they are to be utilised most effectively.

Age and operational service life of a ship

1.4.42 All measures identified in this paper are potentially cost effective as a result of high oil prices. Measures previously considered unaffordable or commercially unattractive may now be feasible and worthy of fresh consideration. Clearly, this equation is heavily influenced by the remaining service life of a ship and the cost of fuel.
Trade and sailing area

1.4.43 The feasibility of many of the measures described in this guidance will be dependant on the trade and sailing area of the vessel. Sometimes ships will change their trade areas as a result of a change in chartering requirements but this cannot be taken as a general assumption. For example wind enhanced power sources might not be feasible for short sea shipping as these ships generally sail in areas with high traffic densities or in restricted waterways. Another aspect is that the world’s oceans and seas each have characteristic conditions and so ships designed for specific routes and trades may not obtain the same benefit by adopting the same measures or combination of measures as other ships. It is also likely that some measures will have a greater or lesser effect in different sailing areas.

1.4.44 The trade a ship is engaged in will also determine the feasibility of some of the measures. Ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers etc.) are likely to choose different methods of carbon reductions when compared to conventional cargo carriers. The length of voyage will also be an important parameter as will safety considerations imposed upon some vessels. As a result, it is likely that the pathway to the most efficient combination of measures will be unique to each vessel within each shipping company.
PART 2 – ILLUSTRATIVE SHIP EFFICIENCY MANAGEMENT PLAN (SEMP)

2.1 Illustrative Ship Efficiency Management Plan

<table>
<thead>
<tr>
<th>Name of vessel:</th>
<th>Capacity (TEU/dwt/Pax/TLM):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel Type:</td>
<td></td>
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<tr>
<td>GRT:</td>
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</tr>
<tr>
<td>Energy Efficiency Measures</td>
<td>Ship/Company Appraisal Comments</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>Ship/Fleet Management Measures</strong></td>
<td></td>
</tr>
<tr>
<td>1. Fleet Management</td>
<td></td>
</tr>
<tr>
<td>a. Measure 1a (e.g., best utilization of fleet capacity)</td>
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<tr>
<td>- [measure summary]</td>
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<tr>
<td>2. Cargo Flow</td>
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<tr>
<td>a. Measure 2a (e.g., optimize cargo flow)</td>
<td></td>
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<tr>
<td>- coordination with port or shipper/charterer for better cargo flow</td>
<td></td>
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<tr>
<td>3. Voyage Planning &amp; Routeing</td>
<td></td>
</tr>
<tr>
<td>a. Measure 3a (e.g., voyage planning)</td>
<td></td>
</tr>
<tr>
<td>- [measure summary] (e.g., acquisition and application of ABC software tool for voyage planning)</td>
<td></td>
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<tr>
<td>b. Measure 3b (e.g., weather routeing)</td>
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<tr>
<td>- [measure summary]</td>
<td></td>
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<tr>
<td>Energy Efficiency Measures</td>
<td>Ship/Company Appraisal Comments</td>
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<tr>
<td>Ship/Fleet Management Measures</td>
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<tr>
<td>c. Measure 3c (e.g., optimized arrival)</td>
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<tr>
<td>- [measure summary]</td>
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<tr>
<td>4. Communication &amp; Training</td>
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<tr>
<td>a. Measure 4a (e.g., energy conservation awareness training)</td>
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<tr>
<td>- Onboard training for energy efficient operation</td>
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<tr>
<td>5. Ship Operation &amp; Handling</td>
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<tr>
<td>a. Measure 5a (e.g., speed optimization)</td>
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<tr>
<td>- [measure summary]</td>
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<tr>
<td>b. Measure 5b (e.g., trim optimization)</td>
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<td>- [measure summary]</td>
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<tr>
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<tr>
<td>Ship/Fleet Management Measures</td>
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<tr>
<td>c. Measure 5c (e.g., optimum ballast)</td>
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<td>- [measure summary]</td>
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<tr>
<td>d. Measure 5c (e.g., optimizing auto-pilot function)</td>
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<tr>
<td>- [measure summary]</td>
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<tr>
<td>6. Engine Performance &amp; Propulsion</td>
<td></td>
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<tr>
<td>a. Measure 6a (e.g., engine performance optimization)</td>
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<tr>
<td>- [measure summary]</td>
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<td>b. Measure 6b (e.g., fuel quality)</td>
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<td>- [measure summary]</td>
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<td>c. Measure 6c (e.g., propeller maintenance)</td>
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<td>- [measure summary]</td>
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<tr>
<td>d. Measure 6d (e.g., propeller modification)</td>
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<tr>
<td>- Fitting of propeller boss fin caps to eliminate hull vortices</td>
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<tr>
<td>e. Measure 6e (e.g., optimum use of bow thrusters)</td>
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<td>- [measure summary]</td>
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<tr>
<td>f. Measure 6f (e.g., shaft generator)</td>
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<td>- [measure summary]</td>
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<tr>
<td>7. Hull Resistance Management</td>
<td></td>
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<tr>
<td>a. Measure 7a (e.g., performance monitoring)</td>
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<tr>
<td>- [measure summary]</td>
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</tbody>
</table>
### Energy Efficiency Measures

**Ship/Fleet Management Measures**

| b. Measure 7b (e.g., hull maintenance) | - [measure summary] |
| c. Measure 7c (e.g., advanced hull coating systems) | - [measure summary] |

<table>
<thead>
<tr>
<th>Ship/Company Appraisal Comments</th>
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</table>

8. Monitoring Energy Consumption

9. Engine Cooling Water

10. Thermal Heat Recovery

11. Pumps, Fans & Electrical Equipment
<table>
<thead>
<tr>
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<tr>
<td>12. Incinerators</td>
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<td>13. Shore power supply</td>
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<td>14. Lighting</td>
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<tr>
<td>15. Air Conditioner systems/cooling systems</td>
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ANNEX 6

INTERVENTION BY INDIA ON DEVELOPMENT OF REGULATORY FRAMEWORK

Thank you Mr. Chairman,

At the very outset of this Working Group Meeting, you stated that this group would discuss technical and operational issues only and not application issues. You had made it clear that application issues would be dealt with at MEPC 59.

The Group has since then worked cohesively in its deliberations on various technical issues and has made substantial progress under your guidance in taking decisions, which are technically correct and justified.

Keeping your assurance in made, that this group will not discuss any issues related to application of the technical measures, this delegation has serious reservations in discussing the topic titled Regulatory Framework.

India would like to thank Japan for its document GHG-WG 2/2/16, however, India has reservations in discussing any regulatory framework for mandatory application of the EEDI during this Working Group Meeting.

India is in the process of developing EEDI formula to suit various types of marine power plant configurations and also during our discussions, several delegations expressed their concern regarding suitability of using current equation for ship-types like container ships, etc.

In light of all these, India is of the view that this group should report to MEPC 59 that no work for finalization of regulatory framework could be done since the group was engaged in finalization of technical issues related to EEDI, EEOI and Ship Efficiency Management Plan, etc.

Thank you Sir.