DESCRIPTION OF THE PACKAGE OF TECHNICAL AND OPERATIONAL REDUCTION MEASURES FOR SHIPS AGREED BY MEPC 59

1 The following circulars were issued (17 August 2009) following MEPC 59 and may be found on the IMO website: www.imo.org:

   .1 the EEDI formula was circulated as MEPC.1/Circ.681, Interim Guidelines on the method of calculation of the Energy Efficiency Design Index for new ships (annex 17 to MEPC 59/24);

   .2 the EEDI verification procedure was circulated as MEPC.1/Circ.682, Interim guidelines for voluntary verification of the EEDI (annex 18 to MEPC 59/24);

   .3 the SEEMP was circulated as MEPC.1/Circ.683, Guidance for the development of a SEEMP (annex 19 to MEPC 59/24); and

   .4 the EEOI was circulated as MEPC.1/Circ.684, Guidelines for voluntary use of the ship EEOI (annex 20 to MEPC 59/24).

IMO’s Energy Efficiency Design Index (EEDI)

2 MEPC.1/Circ.681, Interim Guidelines on the method of calculation of the EEDI for new ships was circulated on 17 August 2009.

Background

2.1 The maritime industries have continuously endeavoured to optimize ships’ fuel consumption, e.g., through the development of more efficient engines and propulsion systems, optimized hull designs and larger ships, and thereby achieved a noteworthy reduction in fuel consumption and resulting CO₂ emissions on a capacity basis (tonne-mile). Although ships are the most fuel efficient mode of mass transport, the Second IMO GHG Study 2009 identified a significant potential for further improvements in energy efficiency mainly by the use of already existing technologies. Additional improvements in hull, engine and propeller designs, together with reduction in operational speed, may lead to considerable reductions as illustrated in the figure below.

Potential reductions of CO₂ emissions by using existing technology and practices

<table>
<thead>
<tr>
<th>DESIGN (New ships)</th>
<th>Saving of CO₂, tonne-mile</th>
<th>Combined</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept, speed and capability</td>
<td>2% to 50%*</td>
<td>10% to 50%*</td>
<td>25% to 75%*</td>
</tr>
<tr>
<td>Hull and superstructure</td>
<td>2% to 20%</td>
<td>5% to 15%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Power and propulsion systems</td>
<td>5% to 15%</td>
<td>5% to 15%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Low-carbon fuels</td>
<td>5% to 15%</td>
<td>5% to 15%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>1% to 10%</td>
<td>1% to 10%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Exhaust gas CO₂ reduction</td>
<td>0%</td>
<td>0%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>OPERATION (All ships)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fleet management, logistics and incentives</td>
<td>5% to 50%*</td>
<td>10% to 50%*</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Voyage optimization</td>
<td>1% to 10%</td>
<td>1% to 10%</td>
<td>25% to 75%+</td>
</tr>
<tr>
<td>Energy management</td>
<td>1% to 10%</td>
<td>1% to 10%</td>
<td>25% to 75%+</td>
</tr>
</tbody>
</table>

* Reductions at this level would require reductions of operational speed.
+ CO₂ equivalent, based on the use of LNG.

Source: Second IMO GHG Study 2009
Purpose of the EEDI

2.2  IMO's Marine Environment Protection Committee (MEPC) has developed the Energy Efficiency Design Index for new ships (MEPC.1/Circ.681) to create stronger incentives for further improvements in ships’ fuel consumption. The purposes of IMO’s EEDI are:

- to require a minimum energy efficiency level for new ships;
- to stimulate continued technical development of all the components influencing the fuel efficiency of a ship;
- to separate the technical and design based measures from the operational and commercial measures (they will/may be addressed in other instruments); and
- to enable a comparison of the energy efficiency of individual ships to similar ships of the same size which could have undertaken the same transport work (moved the same cargo).

2.3  The EEDI provides a transparent basis for comparison of the energy efficiency for individual ships and, when made mandatory, will require ship designers and builders to produce intrinsically energy-efficient ships. The reduction levels were considered in detail by MEPC 60 in March 2010 and will be concluded in September/October. Aan initial reduction of 10 to 30% is possible depending on ship type and size. Once the baseline is set the EEDI value will be tightened incrementally every five years, to keep pace with the technological developments. The EEDI will facilitate shipowners to purchase the most fuel efficient ships for their fleets and charterers and cargo owners in choosing the most energy-efficient ships for their operations.

EEDI coverage

2.4  The EEDI is developed for the larger segments of the world merchant fleet and would cover 87% of emissions from new ships covering the following ship types: oil and gas tankers, bulk carriers, general cargo and container ships, ro-ro carriers (roll-on-roll-off) and passenger ships. However, due to the long economic life of merchant ships, it would take about 20 years to reach this coverage without additional incentives. For ship types not covered by the current formula, suitable formulas will be developed in the near future addressing the largest emitters first.

The EEDI formula

2.5  The EEDI provides a specific figure for an individual ship design, expressed in grams of CO₂ per ship’s capacity-mile (a smaller EEDI value means a more energy-efficient ship design) and calculated by the following formula based on the technical design parameters for a given ship:

\[
\frac{\left( \prod_{i=1}^{M} \sum_{j=1}^{\text{MW}} \left( P_{\text{ME}} C_{\text{ME}} S\text{FG}_{\text{ME}} \right) + \left( P_{\text{AE}} C_{\text{AE}} S\text{FG}_{\text{AE}} \right) \right) + \left( \sum_{i=1}^{M} \sum_{j=1}^{\text{MW}} \left( P_{\text{ME}} C_{\text{ME}} S\text{FG}_{\text{ME}} \right) + \left( P_{\text{AE}} C_{\text{AE}} S\text{FG}_{\text{AE}} \right) \right) - \sum_{i=1}^{\text{ME}} \left( P_{\text{ME}} C_{\text{ME}} S\text{FG}_{\text{ME}} \right)}{f_{C_{\text{ME}} S\text{FG}_{\text{ME}}}}
\]

\( f_{C_{\text{ME}} S\text{FG}_{\text{ME}}}: \text{Capacity} V_{\text{ref}, f_{C}} \)
That can be illustrated by the following simplified formula:

\[
EEDI = \frac{CO_2 \text{ emission}}{\text{transport work}}
\]

2.6 The CO\textsubscript{2} emission represents total CO\textsubscript{2} emission from combustion of fuel at design stage, including propulsion and auxiliary engines, taking into account the carbon content of the fuels in question. If shaft generators or innovative mechanical or electrical energy efficient technologies are incorporated on board a ship, these effects are deducted from the total CO\textsubscript{2} emission. If wind or solar energy is used on board a ship, the energy saved by such measures will also be deducted from the total CO\textsubscript{2} emissions, based on actual efficiency of the systems.

2.7 The transport work is calculated by multiplying the ship’s capacity as designed (deadweight for cargo ships and gross tonnage for passenger ships) with the ship’s design speed measured at the maximum design load condition and at 75% of the rated installed shaft power. Speed is the most essential factor in the formula and may be reduced to achieve the required index.

**Status of the EEDI**

2.8 The EEDI is circulated for trial purposes to ensure its feasibility and for further improvement of the calculation method, as necessary. The EEDI is expected to be made mandatory for new ships on completion of this improvement work, most probably by 2010.

**Future developments**

2.9 The current EEDI formula is not suitable for all ship types or all types of propulsion systems, e.g., ships with diesel-electric, turbine or hybrid propulsion systems will need additional correction factors and MEPC will consider the matter in detail at future sessions. For ship types not covered by the current formula, suitable formulas will be developed in the future addressing the largest emitters first.

**Conclusions EEDI**

2.10 The EEDI will establish a minimum energy efficiency requirement for new ships depending on ship type and size and is a robust mechanism that may be used to increase the energy efficiency of ships stepwise to keep pace with technical developments for many decades to come. The EEDI is a non-prescriptive mechanism that leaves the choice of what technologies to use in a ship design to the stakeholders as long as the required energy-efficiency level is attained enabling the ship designers and builders to use the most cost-efficient solutions.

**Voluntary verification of the EEDI**

3 MEPC.1/Circ.682, Interim guidelines for voluntary verification of the EEDI was circulated on 17 August 2009.
**Background**

3.1 The purpose of the interim guidelines on voluntary verification of the EEDI, which was agreed by MEPC 59 as part of the package of technical and operational measures, is to assist verifiers of the EEDI in conducting the verification in a uniform manner. Uniform application of voluntary verification will capitalize on the experience from trials and will assist MEPC in its further consideration of possible mandatory application of the EEDI to new ships. The guidelines will also assist shipowners, shipbuilders as well as engine and equipment manufacturers, and other interested parties, in understanding the procedures of the voluntary EEDI verification.

**Verification in two stages**

3.2 The attained EEDI should be calculated in accordance with the EEDI Guidelines (MEPC.1/Circ.681). Voluntary EEDI verification should be conducted on two stages: preliminary verification at the design stage, and final verification at the sea trial, before issuance of the final report on the verification of the attained EEDI. The basic flow of the verification process is presented in figure 1.

![Figure 1 – Basic Flow of Verification Process](image)

**Preliminary verification at the design stage**

3.3 For the preliminary verification at the design stage, a shipowner should submit to a verifier (e.g., a Maritime Administration or a Classification Society) an application for the verification and an EEDI Technical File containing the necessary information for the verification and other relevant background documents as required by the guidelines.
**Final verification of the Attained EEDI at sea trial**

3.4 Prior to the sea trial, a shipowner should submit the application for the verification of the EEDI together with the final displacement table and the measured lightweight, as well as other technical information as necessary. The verifier should attend the sea trial and confirm compliance in accordance with the guidelines and the EEDI guidelines.

**Issuance of the EEDI verification report**

3.5 The verifier should issue the Report on the Preliminary Verification of EEDI after it verified the Attained EEDI at design stage in accordance with the guidelines. Following the sea trial, the verifier should issue the final report on the verification of the attained EEDI after it verified the Attained EEDI at the sea trial in accordance with the guidelines.

**Status of the verification guidelines**

3.6 The guidelines should be applied on a voluntary basis to new ships for which an application for EEDI verification has been submitted to a verifier. If the EEDI is made mandatory in the future, the guidelines will form part of the regulatory framework governing the scheme.

**Guidance for the development of a SEEMP**

4 MEPC.1/Circ.683, Guidance for the development of a SEEMP was circulated on 17 August 2009.

**Introduction**

4.1 The purpose of the Ship Energy Efficiency Management Plan (SEEMP) is to establish a mechanism for a company and/or a ship to improve the energy efficiency of ship operations. Preferably, the ship-specific SEEMP is linked to a broader corporate energy management policy for the company that owns, operates or controls the ship, recognizing that no two shipping companies or shipowners are the same. It should also be recognized that the international fleet of merchant vessels comprises a wide range of ship types and sizes that differ significantly in their design and purpose, and that ships operate under a broad variety of different conditions.

4.2 Sea transport has a justifiable image of conducting its operations in an energy-efficient way, and in a manner that creates little impact on the global environment. It is nevertheless the case that enhancement in efficiencies can reduce fuel consumption, save money, and decrease the environmental impacts from ships. While the yield of individual measures may be small, the collective effect across the entire fleet will be significant. In global terms it should be recognized that operational efficiencies delivered by a large number of ships will make a valuable contribution to reducing global carbon emissions.

**Practical approach**

4.3 Mandatory management plans are used to regulate a range of ship operations where traditional command and control regulations would not work, and is also the chosen option for reduction of GHG emissions from operation of ships engaged in international trade. To regulate ship operations by traditional prescriptive regulations (as is the customary practice for technical regulations) is not feasible, e.g., to determine the most energy-efficient speed, optimum ship handling practices or the preferred ballast conditions for all ships in a set of regulations could hardly be done and keeping it updated would not be possible. A management plan is a familiar tool for the shipping industry and provides a flexible
mechanism where shipowners and operations can choose the most cost-effective solutions for their ships and their operations.

4.4 The SEEMP provides an approach for monitoring ship and fleet efficiency performance over time and forces the responsible persons and entities at each stage of the plan to consider new technologies and practices when seeking to optimize the performance of the ship. The Second IMO GHG Study 2009 indicates that a 20% reduction on a tonne-mile basis by mainly operational measures is possible and would be cost-effective even with the current fuel prices, and the SEEMP will assist the shipping industry in achieving this potential.

4.5 The circular provides guidance for the development of a SEEMP that should be adjusted to the characteristics and needs of individual companies and ships. The SEEMP 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 the plan be implemented in a manner which limits any onboard administrative burden to the minimum necessary.

Ship-specific plan

4.6 The SEEMP should be developed as a ship-specific plan by the shipowner, operator or any other party concerned, e.g., the charterer. The SEEMP seeks to improve a ship's energy efficiency through four steps: planning, implementation, monitoring, and self-evaluation and improvement. These components play a critical role in the continuous cycle to improve ship energy management. With each iteration of the cycle, some elements of the SEEMP will necessarily change while others may remain as before.

Guidance on best practices for fuel-efficient operation of ships

4.7 The circular contains guidance on best practices related to voyage performance, optimized ship handling, hull and propulsion system maintenance, the use of waste heat recovery systems, improved fleet management, improved cargo handling and energy management. It also covers areas such as fuel types, compatibility of measures, age and operational service life of a ship as well as trade and sailing area.

A sample form of a SEEMP is presented below for illustrative purposes

<table>
<thead>
<tr>
<th>Name of Vessel:</th>
<th>GT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel Type:</td>
<td>Capacity:</td>
</tr>
<tr>
<td>Date of Development:</td>
<td>Developed by:</td>
</tr>
<tr>
<td>Implementation Period:</td>
<td>From:</td>
</tr>
<tr>
<td>Planned Date of Next Evaluation:</td>
<td></td>
</tr>
</tbody>
</table>
1 MEASURES

<table>
<thead>
<tr>
<th>Energy Efficiency Measures</th>
<th>Implementation (including the starting date)</th>
<th>Responsible Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Routeing</td>
<td>&lt;Example&gt; Contracted with [Service providers] to use their weather routeing system and start using on trial basis as of 1 July 2012.</td>
<td>&lt;Example&gt; The master is responsible for selecting the optimum route based on the information provided by [Service providers].</td>
</tr>
<tr>
<td>Speed Optimization</td>
<td>While the design speed (85% MCR) is 19.0 kt, the maximum speed is set at 17.0 kt as of 1 July 2012.</td>
<td>The master is responsible for keeping the ship speed. The log-book entry should be checked every day.</td>
</tr>
</tbody>
</table>

2 MONITORING

- Description of monitoring tools (e.g. the EEOI, or another suitable indicator/tool)

3 GOAL

- Measurable goals

4 EVALUATION

- Procedures of evaluation

The Energy Efficiency Operational Indicator (EEOI)

5 MEPC.1/Circ.684, Guidelines for voluntary use of the ship EEOI was circulated on 17 August 2009.

Introduction

5.1 Although ships are the most fuel efficient mode of mass transport, the Second IMO GHG Study 2009 identified a significant potential for further improvements in energy efficiency by operational measures, such as fleet management, voyage optimization and energy management. The Study estimated that 10 to 50% reductions of CO₂ emissions (on a capacity·mile basis) are possible through the combined use of these measures. Saving energy at the operational stage is presently addressed by the SEEMP where the Energy Efficiency Operational Indicator (EEOI) will be used as the monitoring tool and to establish benchmarks for different ship segments of the world fleet categorized by ship type and size.

Purpose of the EEOI

5.2 MEPC has developed Guidelines for voluntary use of the ship Energy Efficiency Operational Indicator to establish a consistent approach for measuring ships energy-efficiency at each voyage or over a certain period of time, which will assist shipowners and ship operators in the evaluation of the operational performance of their fleet. As the amount of CO₂ emitted from ships is directly related to the consumption of bunker fuel oil, the EEOI can also provide useful information on a ship’s performance with regard to fuel efficiency.

5.3 The EEOI enables continued monitoring of individual ships in operation and thereby the results of any changes made to the ship or its operation. The effect of retrofitting a new and more efficient propeller would be reflected in the EEOI value and the emissions reduction could be quantified. The effect on emissions by changes in operations, such as
introduction of just in time planning or a sophisticated weather routing system, will also be shown in the EEOI value.

**EEOI coverage**

5.4 The EEOI can be applied to almost all ships (new and existing) including passenger ships, however it cannot be applied to ships that are not engaged in transport work, such as service and research vessels, tug boats or FPSOs, as it is the transport work that is the input value together with emissions (fuel consumed x CO$_2$ factors for different fuel types).

**The EEOI formula**

5.5 The EEOI provides a specific figure for each voyage. The unit of EEOI depends on the measurement of cargo carried or the transport work done, e.g., tonnes CO$_2$/tonnes-nautical miles, tonnes CO$_2$/TEU-nautical miles or tonnes CO$_2$/person-nautical miles), etc. The EEOI is calculated by the following formula, in which a smaller EEOI value means a more energy efficient ship:

$$EEOI = \frac{\text{actual CO}_2\text{ emission}}{\text{performed transport work}}$$

5.6 The actual CO$_2$ emission represents total CO$_2$ emission from combustion of fuel on board a ship during each voyage, which is calculated by multiplying total fuel consumption for each type of fuel (distillate fuel, refined fuel or LNG, etc.) with the carbon to CO$_2$ conversion factor for the fuel(s) in question (fixed value for each type of fuel).

5.7 The performed transport work is calculated by multiplying mass of cargo (tonnes, number of TEU/cars, or number of passengers) with the distance in nautical mile corresponding to the transport work done.

**Status of the EEOI**

5.8 The EEOI is circulated to encourage shipowners and ship operators to use it on a voluntary basis and to collect information on the outcome and experiences in applying it. The EEOI will be used as a monitoring tool in the SEEMP and to establish benchmarks.

**GHG module in GISIS**

5.9 To collect EEOI data and make them accessible to Member States and the shipping industry, a GHG module was established in GISIS (IMO’s central database) to enable further research work and the establishment of benchmarks for different ship segments (type and size). A sample data in the GHG module is presented below. When fuel consumption data, cargo quantity and voyage distance are completed, the CO$_2$ emission and the voyage index will be calculated automatically:

<table>
<thead>
<tr>
<th>HFO (tonnes)</th>
<th>LNG (tonnes)</th>
<th>MDO (tonnes)</th>
<th>Cargo unit</th>
<th>Distance (n.miles)</th>
<th>CO$_2$ emission</th>
<th>Voyage index</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.46</td>
<td>---</td>
<td>2</td>
<td>475.2</td>
<td>967</td>
<td>145</td>
<td>315</td>
</tr>
<tr>
<td>108.78</td>
<td>---</td>
<td>0.8</td>
<td>1051.2</td>
<td>1861</td>
<td>341</td>
<td>174</td>
</tr>
</tbody>
</table>