Greenhouse Gas Emissions from Ships

Regulations – Energy Efficiency for Ships (MARPOL Annex VI Chapters 4)

Masao Yamasaki
Marine Environment Division, IMO

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Greenhouse Gas (GHG) Emissions from Ships

– Contents –

1. Global GHG Emissions and Role of International Shipping
2. IMO Work to address GHG Emissions from Ships
3. MARPOL Annex VI Chapter 4
   – Regulations on Energy Efficiency for Ships
     1. Energy Efficiency Design Index (EEDI)
     2. Ship Energy Efficiency Management Plan (SEEMP)
     3. Survey and Certification Requirements
     4. Guidelines
4. Third IMO GHG Study 2014
1. Global GHG Emissions and Role of International Shipping
Global GHG Emissions and Role of International Shipping

- **Global Warming:** Greenhouse effect of the earth’s atmosphere is enhanced by heavy use of fossil fuels, etc. 

  Temperature rises

- **Greenhouse effect:** The effect that the surface of the earth is kept warm by the existence of the atmosphere
Mechanism of Greenhouse Effect

Greenhouse gases absorb re-radiated heat from earth and re-emit the heat back to earth.
Global GHG Emissions and Role of International Shipping

- **Greenhouse Gases (GHG):**
  - Carbon dioxide (CO$_2$) 64%
  - Methane 19%
  - Freon gas 10%

Most GHG emissions from ships are CO$_2$
Global GHG Emissions and Role of International Shipping

Trend of CO₂ Concentration in Atmosphere

Source: Japan Meteorological Agency, Climate Change Monitoring Report
Global GHG Emissions and Role of International Shipping

Trend in Northern Hemisphere Temperature

1900 – 2000 (100 years)
Increase 0.60 deg. ($\Delta 0.006$ deg/year)

Last 10 years
Increase 0.13 deg. ($\Delta 0.013$ deg/year)

During 100 years from now, temperature increase could be 1.1 – 6.4 degrees

Source: IPCC AR4 Report
Global GHG Emissions and Role of International Shipping

Kyoto Protocol

- **UNFCCC**: United Nations Framework Convention on Climate Change

- The Protocol was adopted by **COP3 in Kyoto (1997)** (COP: Conference of Parties)

- GHG reduction targets are assigned to Developed Countries

- Reduction targets must be achieved during **first commitment period (2008-2012)**

- Developing countries are not obligated to reduce GHG emissions: **Common but differentiated responsibility (CBDR)**
Global GHG Emissions and Role of International Shipping

Reduction Target (Kyoto Protocol)


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<thead>
<tr>
<th>Country</th>
<th>Emission Increase (%)</th>
<th>Emission Reduction (%)</th>
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<tbody>
<tr>
<td>Annex B</td>
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<td>-5.2</td>
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<td>Iceland</td>
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Global GHG Emissions and Role of International Shipping

International Shipping (Ocean-going Vessels) is outside of regulatory framework of Kyoto Protocol

UNFCCC requested IMO to study reduction measures for CO₂ emissions from International Shipping

Characteristics of International Shipping

- World-wide single market
- Involves many stakeholders (Flag, Charterers, Owners, etc.)

Which country should take responsibility?
Global GHG Emissions and Role of International Shipping

International climate change negotiations

“The Parties included in Annex I shall pursue limitation or reduction of emissions of GHG.....from aviation and marine bunker fuels, working through the.....International Maritime Organization”

[Extracts from Article 2.2 of the Kyoto Protocol, 1997]
Shipping emissions under UNFCCC

No text on international transport in current texts as there are three challenging obstacles:

- Should a reduction target be set for international shipping, and if so, what should the target be and should it be set by UNFCCC or IMO?

- Should the new UNFCCC treaty state how revenues from a market-based instrument under IMO should be distributed and used (climate change purposes in developing countries)?

- How should the balance between the basic principles under the two conventions be expressed in the new treaty text (UNFCCC and its fundamental CBDR principle and, on the other hand, the IMO constitutive Convention with its non discriminatory approach)?

Kyoto Protocol second commitment period ends 2020
UN Secretary-General “Climate Summit”, NY Sep. 2014
Focus on draft of new global instrument, Paris Dec. 2015
UNFCCC new global agreement on climate change

- “Negotiation text” issued for new global climate change agreement expected to be agreed at UNFCCC COP 21, Paris, France, December 2015.

- Refers to emissions from bunker fuels for international maritime transport and IMO in sections on “mitigation” and “finance”.

- Marshall Islands called for a quantifiable reduction target for greenhouse gas emissions from international shipping.

- MEPC 68 took the view that the priority at this stage should be to continue its current work, in particular, to focus on further reduction of emissions from ships through the finalization of a data collection system. The Marshall Islands proposal could then be further addressed at an appropriate future session of the committee, recognizing the need to move forward cautiously on the proposal.
2. IMO Work to address GHG Emissions from Ships
IMO Work to address GHG Emissions from Ships

**CO₂ Emission** = (Activity) \times (Energy Efficiency)

- **Activity**: Transport volume \times Distance (ton mile)
- **Energy Efficiency**: CO₂ emissions per activity

To reduce CO₂ emissions from international shipping:

- Decrease activities of shipping
- Cause stagnation of world economy
- Improve energy efficiency of shipping
Measures for Improving Efficiency

(1) **Technical Measures**

Energy efficiency improvement using “Enhanced Hardware”

(2) **Operational Measures**

Energy efficiency improvement through “Operational Efforts” without hardware modifications
IMO Work to address GHG Emissions from Ships

1. Technical Measures: Efficiency Improvement by Enhanced Hardware

- Improvement of Hull Form (Reduction of Propulsion Resistance)
- Improvement of Propeller (Improvement in Propulsion Efficiency)
- Hull Appendage for Energy Saving
- Waste Heat Recovery
- Utilization of Renewable Energy, etc.
IMO Work to address GHG Emissions from Ships

Index for evaluating the effectiveness of Technical Measures:

EEDI (Energy Efficiency Design Index)

\[
\text{EEDI} = \frac{\text{CO}_2 \text{ Emissions} (g/h)}{\text{Transport work (ton \cdot mile/h)}}
\]

- EEDI is one of the specification of ships, which measures the CO\(_2\) emitted (grams of CO\(_2\) per tonne nautical mile) from ship.
- EEDI is calculated from ship design and engine performance data.
IMO Work to address GHG Emissions from Ships

2. Operational Measures: Efficiency Improvement by Operational Efforts

- Optimization of Operating plan for each ship or fleet
- Speed Reduction
- Weather Routing
- Just in Time arrival in Port
- Maintenance of Hull
- Maintenance of Engine, etc.
IMO Work to address GHG Emissions from Ships

Index for evaluating the effectiveness of Operational Measures:

**EEOI (Energy Efficiency Operational Indicator)**

\[
EEOI = \frac{\text{CO2 factor} \times \text{FOC (g)}}{\text{Cargo Mass (ton) \times Sailed Distance (mile)}} \quad \text{(g/ton mile)}
\]

Management Plan for Implementing Operational Measures:

**SEEMP (Ship Energy Efficiency Management Plan)**
IMO Work to address GHG Emissions from Ships

EEDI Calculation and verification is required

Having SEEMP is required

EEOI improves when full load and / or at calm sea

EEOI gets worse when partial load and / or at rough sea

Fixed value throughout ship’s life
IMO Work to address GHG Emissions from Ships

IMO MEPC 62 (July 2011)

Regulations for reduction of GHG (Greenhouse Gas) from maritime sector were adopted as Amendment to MARPOL Annex VI

Entry into force on 1 Jan. 2013

• **EEDI** Energy Efficiency Design Index
• **SEEMP** Ship Energy Efficiency Management Plan
• **IEE Cert.** International Energy Efficiency Certificate
<table>
<thead>
<tr>
<th>Resolution MEPC.176(58)</th>
<th>Resolution MEPC.203(62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter III</td>
<td>Chapter III</td>
</tr>
<tr>
<td>Reg. 12 Ozone Depleting Substances</td>
<td>Reg. 12 Ozone Depleting Substances</td>
</tr>
<tr>
<td>Reg. 13 Nitrogen Oxides(NOx)</td>
<td>Reg. 13 Nitrogen Oxides(NOx)</td>
</tr>
<tr>
<td>Reg. 14 Sulphur Oxides(SOx) and Particular Matter</td>
<td>Reg. 14 Sulphur Oxides(SOx) and Particular Matter</td>
</tr>
<tr>
<td>Reg. 15 Volatile Organic Compounds (VOCs)</td>
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</tr>
<tr>
<td>Reg. 16 Shipboard Incineration</td>
<td>Reg. 16 Shipboard Incineration</td>
</tr>
<tr>
<td>Reg. 17 Reception Facilities</td>
<td>Reg. 17 Reception Facilities</td>
</tr>
<tr>
<td>Reg. 18 Fuel Oil Availability and Quality</td>
<td>Reg. 18 Fuel Oil Availability and Quality</td>
</tr>
<tr>
<td>Chapter 4</td>
<td></td>
</tr>
<tr>
<td>Reg. 19 Application</td>
<td></td>
</tr>
<tr>
<td>Reg. 20 Attained EEDI</td>
<td></td>
</tr>
<tr>
<td>Reg. 21 Required EEDI</td>
<td></td>
</tr>
<tr>
<td>Reg. 22 SEEMP</td>
<td></td>
</tr>
<tr>
<td>Reg. 23 Promotion of technical co-operation and transfer of technology relating to the improvement of energy efficiency of ships</td>
<td></td>
</tr>
<tr>
<td>Appendix I ~ VI</td>
<td>Appendix I ~ VI</td>
</tr>
<tr>
<td></td>
<td>Appendix VIII Form of International Energy Efficiency(IEE) Certificate</td>
</tr>
</tbody>
</table>
Resolution A.963(23) (December 2003)


IMO’s GHG Work has three distinct routes:

- **Technical**: mainly applicable to new ships – EEDI;
- **Operational**: applicable to all ships in operation – SEEMP and EEOI; and
- **Market-based**: carbon price for shipping, incentive, may generate funds.

A.963(23) requests MEPC to:

- develop a work plan with timetable – technical/operational measures in place since 2013; MBMs under discussion currently suspended
- establish GHG baseline and develop CO₂ indexing methodology
IMO initiatives for GHG emissions control from ships

- **EEDI**: IMO Initiatives
- **SEEMP**: IMO Initiatives
- **EEOI**: IMO Initiatives
- **MRV** and **MBMs**: IMO Initiatives

**Owners or charterers?**

- **EEDI and SEEMP**: Mandatory from 2013
- **EEOI**: Voluntary
- **MRV**: Under discussion
- **MBMs**: Currently suspended