Outline of CO₂ Emissions Regulation
Measures in IMO and impact on the shipbuilding Industry

3rd ASEF in China
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Background

- Circumstance of Global Warming
Reduction of GHG Emissions from Shipping

UNFCCC : KYOTO PROTOCOL (December, 1997)

- The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from Aviation and Marine Bunker Fuels, working through the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO).

- The Parties included in Annex I shall ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases do not exceed their assigned amounts, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

IMO POLICIES AND PRACTICES : Resolution A.963(23) (Dec., 2003)

- Establishment of a GHG Emission Baseline
- Development of a Methodology to describe a GHG Emission Index
- Development of Guidelines of GHG Emission Indexing Scheme
- Evaluation of Technical, Operational and Market-Based Solutions
- Development a Work Plan with a Timetable
- Review on the continuing IMO Policies and Practices
- Co-operation with UNFCCC and ICAO

Source: IMO MEPC59/INF.10
International shipping emitted 870 million tonnes (approx. 2.7% of the global total. Technical and operational measures has the potential to reduce the emissions rate by 25% to 75% below the current levels. In the absence of global policies to control GHG emissions, the emissions could increase between 150% to 250% by the year 2050 due to the expected growth in international trade.
Seaborne Transport & World GDP

- Seaborne Transport
- World GDP

Seaborne Transport [10 billion]

1985: 3 billion
1986: 3.5 billion
1987: 2 billion
1988: 2.5 billion
1989: 1.5 billion
1990: 1 billion
1991: 0.5 billion
1992: 0 billion

World GDP (compared to 1985)

1985: 20,000 billion
1986: 25,000 billion
1987: 15,000 billion
1988: 10,000 billion
1989: 5,000 billion
1990: 0 billion

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Outline of CO₂ Emissions Regulation Measures in IMO's
Outline of CO₂ Emissions Regulation Measures in IMO

How to Reduce?

A Reduce the amount of Transportation → Affect Sea trade
B Improve Efficiency
  B-1 TECHNICAL
  B-2 OPERATIONAL

Market Based Measures

MBI: Market-Based Instrument
- Global Emission Trading Scheme (ETS)
- Global Contribution Scheme (Levy)
- Other

Technical & Operational Measures → MEPC Circulars

CO₂ Emission (g) = Transportation (ton-mile) × Emission Efficiency (g/ton-mile)

EEDI
(Energy Efficiency Design Index)
Performance at the stage of design and construction by:
  • Calculating attained EEDI
  • Verifying EEDI
  • Reduce Required EEDI step by step

SEEMP
(Ship Energy Efficiency Management Plan)
Performance improvement in operation by:
  • Onboard Management plan
  • Monitoring EEOL (Energy Efficiency Operational Indicator)
Technical & Operational Measures ; EEDI, EEOI & SEEMP

Design & Construction

CO₂ Emission

EEDI

EEOI

Operation

Speed control, Weather Routing, Well maintenance, Optimum trim and draft etc.

EEDI = \frac{FOC \times C}{Capacity \times Vs} (g/ton-mile)

EEOI = \frac{Fuel \text{ (ave.)} \times C}{Cargo \times Distance} (g/ton-mile)

SEEMP

Ship Energy Efficiency Management Plan

Performance improvement by the effort in operation

Delivery

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How to use Technical & Operational Measures

In Case of New Ship

1. EEDI
   - Design: Calculate EEDI
   - Construction: Verified EEDI
   - Sea Trial: Verified EEDI
   - Operation

2. Verification
   - Interim Guidelines on the method of calculation of the EEDI (MEPC.1/Circ.681)
   - Interim Guidelines for voluntary verification of the EEDI (MEPC.1/Circ. 682)

3. SEEMP
   - MEPC 59

4. EEOI
   - Interim Guidelines for voluntary use of the EEOI (MEPC.1/Circ.684)

Technical and operational measures ; developed in MEPC.59
→ Trial purposes or Voluntary Implementation

1. Interim Guidelines on the method of calculation of the EEDI (MEPC.1/Circ.681)
2. Interim Guidelines for voluntary verification of the EEDI (MEPC.1/Circ. 682)
3. Guidance for the development of a SEEMP (MEPC.1/Circ. 683)
4. Guidelines for voluntary use of the EEOI (MEPC.1/Circ.684)
Concept of Maritime Emission Trading Scheme (ETS)

If total allowance for the shipping sector total is small, Shipping Sector should purchase credits continuously!

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Concept of Global Contribution Scheme (Levy)

- Contributions (per unit fuel)
- GHG Fund
- Mitigation and Adaptation projects
- R&D on low emission ships
- IMO – Technical Cooperation
- Human resource development
- Investment on Infrastructure
- Development of ship recycling capability

Labeling
Evaluated by EEOI records

Leveraged Incentive for Efficiency Improvement
The effort will be rewarded by refund

Contributing to the adaptation of developing countries and to investment to reduce CO2 emission

(MEPC 59/4/34)
Current Status (MEPC59) and Future Plan

**Legal Instrument**; Defer consideration of all documents addressing the type of legal instrument and application issues, when the issues could be discussed in light of the outcome of COP 15 (Dec., 2009 in Copenhagen)

**Market-based measures**; agreed work plan;
- MEPC 60 to consider, on the basis of further detailed outlines of possible market-based measures, the methodology and criteria for feasibility studies and impact assessments.
- MEPC 61 to clearly indicate which market-based measure the Committee wishes to evaluate further
- MEPC 62 to report its progress to the 27th Assembly

**Position of IMO**; Any regulatory scheme should be developed and enacted by IMO

**Mitigation and Adaptation**; Greater part of any funds by MBI to be used for climate change purposes in developing countries (general preference)
Development of Technical and Operational measures
EEDI; Energy Efficiency Design Index

Formula of EEDI ; Interim Guidelines for New Ships(MEPC.1/Circ.681)

\[ \text{Reduction due to innovative technology} = \frac{\text{Emission from M/E} - \text{Emission from Aux. Engine} - \text{Emission from Shaft Motor}}{\text{PME, PAE}} \]

**PME, PAE**: Power of main and auxiliary engines

**P_{PTI}**: Power consumption of each shaft motor

**P_{AEeff}**: Main engine power reduction due to innovative mechanical energy efficient technology

**P_{eff}**: Auxiliary power reduction due to innovative electrical energy efficient technology

**C_{FME}, C_{FAE}**: non-dimensional conversion factor between fuel consumption and CO2 emission based on carbon content. (Table given)

**SFC_{ME}, SFC_{AE}**: certified specific fuel consumption of main and auxiliary engines

**f_j**: correction factor to account for ship specific design elements (for ice-class, table given)

**f_i**: the capacity factor for any technical/regulatory limitation on capacity (for ice-class, table given)

**f_w**: non-dimensional coefficient indicating the decrease of speed in BF6. (=1.0)

**f_{eff}**: availability factor of each innovative energy efficiency technology.(=1.0 for waste energy recovery system)

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Major Outstanding issues on EEDI

- Formulation; Still matured?
- Type of the vessel; Dominant Ship Type Only?
- Non-Conventional Type of the Vessel; How to treat?
  - Turbine Propulsion, Diesel – Electric Propulsion, Hybrid Propulsion
- Electric Power Table; Can be verified?
- Deadweight of C/S; Operational draft much different from max. draft.
- Correction Factor; For CSR, additional Safety measures
- Availability Factor (feff); How to define?
- Speed Decrease Factor; When Guidelines / Standard Table becomes available?

→ Guidelines would be reviewed by trial use.
Formula for Establishing EEDI Baseline

- Basic Concept of Regression Formula (Proposed by Denmark MEPC58/4/8)
- Exponential Regression to be applied for new vessels built in last 10 years

\[
\text{Baseline value} = a \cdot \text{Capacity}^{-c}
\]

- Lloyd’s Register Fairplay’s database is used currently
- However, comments are raised regarding computation method, database accessibility, integrity and interpretation, etc.
- Concerns are expressed about the effect of new rules (CSR, NOx Tier2), penalization of safety equipment / facilities in excess of rule requirement, voluntarily
- Ships which has Non-Conventional propulsion system (Steam Turbine, Electric-Diesel) need further consideration
- Parameters should be decided in transparent manner within IMO

Source: IMO MEPC58/4/8
Verification of EEDI

- Interim Guidelines for Voluntary Verification (MEPC.1/Circ.682);
- Two stages; Preliminary at design, and Final at Sea Trial;
- Technical File; DWT, MCR, SFC, Power Curve, etc.
- Speed; verified by Model Test at design stage and by Sea Trial in final.
  - In a long history of Shipbuilding Industry, Speed has never been verified by 3rd party.
- Additional Information; Detail Report of model test, Lines, Calculation Process, Model-Ship correlation, Lightweight (To protect shipbuilders’ confidential information, it should be provided directly to the verifier).
- Sea Trial; Verifier attend. Measurement and Analysis method should be verified by attending verifier and document.
- Guidelines would be reviewed by trial use.

Basic Flow of Verification Process
EEOI ; Energy Efficiency Operating Indicator

Guidelines for Voluntary use (MEPC.1/Circ.684);

EEOI = [Mass of CO2] (t) / [Transportation Work] (ton-mile)

→ Represents Operation Efficiency over a consistent period (trading pattern)
When it applies voyages in some period, it gives average EEOI (Rolling Average)

CO2 Indicator Report (example)

<table>
<thead>
<tr>
<th>Name and Type of Ship</th>
<th>Fuel Consumption (FC) at Sea and in Port in Tonnes</th>
<th>Voyage or Time Period Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voyage or day (i)</td>
<td>Fuel Type (HFO)</td>
<td>Fuel Type (LFO)</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ EEOI = \frac{100 \times 3.114 + 25 \times 3.131}{(25,000 \times 300) + (0 \times 300) + (25,000 \times 750) + (15,000 \times 150)} = 13.47 \times 10^{-4} \]

Monitoring on a regular basis and verified by internal audits under ISM Code.

Source ; MEPC 59/4/34

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SEEMP; Ship Energy Efficiency Management Plan

Guidance for the Development of SSEMP (MEPC.1/Circ.683);
* Documentation for establish internal mechanism to improve Energy Efficiency
* Linked to Corporate Energy Management Policy (EMS)
* 4-Steps;
  1. Planning
  2. Implementation
  3. Monitoring
  4. Self-Evaluation and Improvement
* Goal Setting; voluntary (no need to announce to the public)
* Best Practice for Energy Efficient Operation could be selected

Information on Described on SSEMP
1. Measures to improve Energy Efficiency
2. Method / Tools of Monitoring
3. Goal (measurable)
4. Procedures of Evaluation

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CO$_2$ Emission Reduction Technologies
Reduction Measures of EEDI

DWT is a parameter of Required EEDI formula. Size Up can reduce EEDI, but it is not so effective than Speed Down or New Technology.

However,

Size Up is still one of the choice to reduce CO2!
Efficiency Improvement Scenario

**New ship**

- Speed reduction/Enlargement
  - Change SPEC
- Application of New technology
  - Introduce New technologies

Implementation of case study

### Efficiency Improvement Scenario of New ships

<table>
<thead>
<tr>
<th>Contract</th>
<th>2012-2016</th>
<th>2017-2021</th>
<th>2022-2026</th>
<th>2027-2031</th>
<th>2032-2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk/General Cargo</td>
<td>25%</td>
<td>40%</td>
<td>45%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Tanker</td>
<td>35%</td>
<td>40%</td>
<td>55%</td>
<td>55%</td>
<td>55%</td>
</tr>
<tr>
<td>VLCC</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Container</td>
<td>35%</td>
<td>45%</td>
<td>55%</td>
<td>65%</td>
<td>70%</td>
</tr>
</tbody>
</table>

### Existing ship

10% speed reduction (as to container ships, 15% speed reduction)
## Estimated Efficiency Improvement for new ships

### - in the case of Panamax Bulker

<table>
<thead>
<tr>
<th>Speed &amp; Size</th>
<th>Present</th>
<th>2012-2017</th>
<th>2022-2027</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (kt)</td>
<td>14.0</td>
<td>12.6 (10.0%dwn)</td>
<td>12.5 (10.7%dwn)</td>
<td>Min.12.5kt</td>
</tr>
<tr>
<td>DWT</td>
<td>83,000</td>
<td>91,300 (15.0%up)</td>
<td>99,500 (20.0%up)</td>
<td></td>
</tr>
<tr>
<td>EEDI</td>
<td>3.72</td>
<td>2.94 (-21.0%)</td>
<td>2.81 (-24.5%)</td>
<td></td>
</tr>
</tbody>
</table>

*New Tech.*

| Wave making resistance | — | ○ | ○ |
| CRP                     | — | ○ | ○ |
| Low Resistance Rudder   | — | N/A | ○ |
| Stern Shape             | — | N/A | ○ |
| Spray Prevention        | — | N/A | ○ |
| Air Lubrication         | — | N/A | ○ |
| Multi Shafts            | — | N/A | ○ |
| Improvement             | — | 9.95% | 31.44% |

| EEDI | 3.72 | 2.65 (-28.8%) | 1.93 (-48.2%) |

*New technologies indicated above are examples.*

(Details in MEPC 59/INF.27)
Projection of CO2 Emission (A1B Base)

- **New Technologies**
  - 2050: 4817Mt → 2363Mt
  - 2453Mt reduction (49%)

- ** Applied step by step**
  - 2040: 2978Mt → 1747Mt
  - 1273Mt reduction (43%)

- **Emissions from Existing Ships**

- **CO2 emissions from New Ships**

- **Emission curve**

Projection of CO2 Emission (B2 Base)

Example of new technology

New Technologies

CO2 emissions from Existing Ships

Emissions from Existing Ships

CO2 emissions from New Ships

Applied step by step

2050: 2957Mt→1486Mt
1471Mt reduction (50%)

2040: 2067Mt→1213Mt
854Mt reduction (41%)

BAU

Emission curve
Conclusion; Impact on Shipbuilding Industry

- Development of CO₂ Emissions Regulation Measures is still in progress and it should be managed by IMO. Regulations should be transparent and eliminate escape route.

- Energy Efficient Technologies is effective not only against Global Warming but also Shipping Economy.

- Near Future, when Shipping Sector face the lack of Bunker Oil and its price increase, operator will easily recover initial investment of Energy Efficient Technologies. Also, the price must be pushed by the demand for Low Sulfur Fuel (1,000$/t ?).

- Cost Effective Technical Measures to reduce CO₂ emissions would be a lot and it is not a dream to achieve 50% reduction.

- It is obvious that Shipping is the most energy efficient transportation mode in the world.

- Shipbuilding industry should continue the efforts to develop new technologies to reduce /eliminate CO₂, which support sustainable growth of shipping industry.