INTERNATIONAL MARITIME ORGANIZATION

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MARINE ENVIRONMENT PROTECTION COMMITTEE
59th session
Agenda item 4

MEPC 59/4/15
10 April 2009
Original: ENGLISH

PREVENTION OF AIR POLLUTION FROM SHIPS

Energy Efficiency Operational Indicator (EEOI)

Report of the correspondence group

Submitted by Japan (the Coordinator of the correspondence group)

SUMMARY	
Executive summary:	This document provides the report of the correspondence group established by MEPC 58 to review the Energy Efficiency Operational Index and draft Guidelines for the Energy Efficiency Operational Indicator for consideration with a view to approval of the Committee
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.2
Action to be taken:	Paragraph 18
Related documents:	MEPC/Circ.471; MEPC 58/4, MEPC 58/4/11, MEPC 58/4/13, MEPC 58/WP.8 and MEPC 58/23

Background and Terms of Reference

1 The correspondence group on review of the Energy Efficiency Operational Index (MEPC/Circ.471) was established at the 58th session of the Committee with Japan as the coordinator. The group was instructed to:

.1 prepare a draft revised text of the Energy Efficiency Operational Index (MEPC/Circ.471), taking into account documents MEPC 58/4 (annex 7), MEPC 58/4/11, MEPC 58/4/13, MEPC 58/WP.8 and other relevant documents as well as input and comments from participating Member Governments and observer organizations;

.2 provide status of its work, as appropriate, to the second intersessional meeting of the Working Group on Greenhouse Gas Emissions from Ships (GHG-WG 2); and

.3 submit a written report with a revised text of the Energy Efficiency Operational Index to MEPC 59 for consideration.

Participation

2 The coordinator communicated with representatives of the following Member States, intergovernmental and non-governmental organizations for the preparation of this report:

AUSTRALIA	FINLAND	MARSHALL ISLANDS
BELGIUM	FRANCE	NETHERLANDS
BRAZIL	GERMANY	NORWAY
CANADA	GREECE	SWEDEN
CHINA	INDIA	TURKEY
CYPRUS	IRAN, ISLAMIC REPUBLIC OF	UNITED KINGDOM
DENMARK	JAPAN	UNITED STATES

EUROPEAN COMMISSION
INTERNATIONAL CHAMBER OF SHIPPING (ICS)
BIMCO
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)

Technical Considerations

3 The correspondence group used the proposed text for revision of the interim guidelines contained in MEPC/Circ.471 in document MEPC 58/4/13 submitted by INTERTANKO, OCIMF and BIMCO as the basis for its considerations.

Outcome of GHG-WG 2

4 As instructed by the Committee, the coordinator of the correspondence group reported the status of its work to the second intersessional meeting of the Working Group on Greenhouse Gas Emissions from Ships (GHG-WG 2) that was held at the IMO headquarters from 9 to 13 March 2009. The correspondence group received a set of recommendations from GHG-WG 2 as set out in annex 2 to this document.

5 The group noted the agreement by GHG-WG 2 that the title of the EEOI should be “Energy Efficiency Operational Indicator”, e.g., replacement of the word “Index” with “Indicator”. It was recognized that the calculated EEOI was not a ship specific character or quality (Index), but rather an “Indicator” demonstrating how the ship had been operated. This agreement at GHG-WG 2 is reflected in the draft EEOI as set out in annex 1 to this document.

6 However, an opinion was expressed within the correspondence group that the EEOI should continue to be described as an “Index”, and that the agreement by GHG-WG 2 need to be further considered by MEPC 59.

Fuel to Carbon conversion factor

7 Having received the recommendation of GHG-WG 2 that the Carbon to CO_2 conversion factors should be harmonized with those in the EEDI, the correspondence group prepared draft paragraph 3 "Fuel mass to CO_2 mass conversion factor (C_F)" in the Appendix to the EEOI Guidelines, which values are identical to those in draft EEDI guidelines prepared by GHG-WG 2.

Definition of voyage

8 Having received the recommendation of GHG-WG 2 that a definition for "voyage" should be developed for inclusion in the guidelines and noting the shortage of time, the coordinator developed a draft definition of voyage in square brackets in the draft EEOI (paragraph 3.6 of the Guidelines in annex 1). The correspondence group members were invited to further consider the draft definition and submit comments to MEPC 59.

Rolling Average

9 The correspondence group received support for the introduction of the concept of a "rolling average" of the EEOI as proposed in paragraph 8 of document MEPC 58/4/13 (INTERTANKO, OCIMF and BIMCO). GHG-WG 2 also supported this view. Therefore, the concept of a rolling average was introduced in the Guidelines (paragraph 6.2 and Appendix). However, during a closer examination of the proposal in paragraph 8 of document MEPC 58/4/13, it was found that it might be necessary to check the proposed calculation equation.

Unit for cargo capacity and work done

10 The view was expressed at the GHG-WG 2 meeting that the cargo capacity unit in the EEOI should be harmonized with the unit in the draft guidelines of the EEDI. Others expressed the view at GHG-WG 2 that the number of boxes (TEU) for container vessels and the volume of bulk cargoes should be allowed as options for the purpose of EEOI calculations.

11 The correspondence group noted the agreement by GHG-WG 1 (Oslo, June 2008) contained in document MEPC 58/4, that after a thorough debate on the merits of using TEU vs. DWT for calculating the operational index for container ships, GHG-WG 1 agreed that both parameters should continued to be allowed (as in the interim guidelines contained in MEPC/Circ.471) to gain further experience. However, a cautious approach to the use of TEU should be taken for the time being as there is no mandatory requirement to declare the total cargo capacity of a containership in TEU, and it is a well-known fact that some companies do not disclose these data for commercial reasons.

12 Taking into account the opinions expressed at GHG-WG 2 as described in paragraph 10 above and at GHG-WG 1 described in paragraph 11 above, the correspondence group prepared the draft in such a way that both DWT and TEU are equal options for cargo capacity of containerships (pure containerships).

13 In the case of combination carriers (containers and other cargoes), DWT should be used as the cargo capacity unit with assumptions that the mass of a loaded container is 10 tonnes and the empty mass of a container is 2 tonnes.

14 The correspondence group, while noting the agreement by GHG-WG 2 that GT should be used for passenger ships, also noted that the number of passengers carried would have merit as an indicator of "work done" by passenger ships for the purpose of the EEOI. Therefore, the use of number of boxes (TEU) for container vessels and the number passengers for passenger vessels were maintained in paragraph 3.5 of the draft guidelines. This matter should be further considered at MEPC 59.

Other recommendations from the intersessional working group meeting

15 The correspondence group also considered the other recommendations from the intersessional working group (GHG-WG 2), namely that the guidelines on the EEOI should be prepared taking into account the possibility use of the EEOI and ways to differentiate the cargo voyage and the ballast voyage.

16 While believing that the draft guidelines set out in annex 1 to this document has the flexibility to accommodate the request by GHG-WG 2, additional flexibility might be provided in the definition of voyage, in particular how to deal with fuel consumption of ships while in port. However, the correspondence group did not have sufficient time to discuss this in any detail, and the matters should be further considered at MEPC 59.

Draft MEPC Circular

17 The correspondence group prepared the revised text of MEPC/Circ.471 as set out in annex 1 to this document together with draft Guidelines for voluntary use of the EEOI.

Action requested of the Committee

18 The Committee is invited to consider the report above and, in particular, the draft MEPC Circular and the draft Guidelines on the EEOI as set out in annex 1 to this report and take action as appropriate.

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ANNEX 1

DRAFT MEPC CIRCULAR

GUIDELINES FOR VOLUNTARY USE OF A SHIP ENERGY EFFICIENCY OPERATIONAL INDICATOR (EEOI)

1 The Marine Environment Protection Committee, at its [fifty-ninth] session (July 2009), approved the Guidelines for Voluntary use of a Ship Energy Efficiency Operational Indicator (EEOI), as set out in the annex.

2 Member Governments are invited to bring the guidelines to the attention of all parties concerned and recommend them to use the guidelines.

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GUIDELINES FOR VOLUNTARY USE OF A SHIP ENERGY EFFICIENCY OPERATIONAL INDICATOR (EEOI)

1 The Conference of Parties to the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, held from 15 to 26 September 1997 in conjunction with the Marine Environment Protection Committee's fortieth session, adopted Conference resolution 8, on CO_2 emissions from ships.

2 IMO Assembly resolution A.963(23) on IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions from Ships urged the Marine Environment Protection Committee (MEPC) to identify and develop the mechanism or mechanisms needed to achieve the limitation or reduction of Greenhouse Gas (GHG) emissions from international shipping and, in doing so, to give priority to the establishment of a GHG baseline; and the development of a methodology to describe the GHG efficiency of a ship in terms of GHG emission indicator for that ship.

3 As urged by the Assembly, MEPC 53 approved Interim Guidelines for Voluntary Ship CO_2 Emission Index for Use in Trials. Further consideration of these issues at later sessions from MEPC 54 to MEPC [59] leads to the adoption of a mandatory Energy Efficiency Design Index (EEDI) for new ships and a voluntary Energy Efficiency Operational Indicator (EEOI).

4 These Guidelines can be used to establish a consistent approach for voluntary use of an EEOI, which will assist ship owners, ship operators and parties concerned in the evaluation of the performance of their fleet with regard to CO_2 emissions. As the amount of CO_2 emitted from a ship 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 These Guidelines may be updated periodically, to take account of:

- Operational experiences from use of the indicator for different ship types, as reported to MEPC by industry organizations and Administrations; and

- Any other relevant developments.

6 Industry organizations and interested Administrations are invited to promote the use of the attached Guidelines or equivalent approaches and their incorporation in company and ship environmental management plans. In addition, they are invited to report their experience in applying the EEOI concept back to MEPC.

7 In addition to these guidelines, due account should be taken of the pertinent clauses within the ISM Code in voluntary basis along with reference to relevant industry guidance on the management and reduction of CO_2 emissions.

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GUIDELINES FOR VOLUNTARY SHIP ENERGY EFFICIENCY OPERATIONAL INDICATOR (EEOI)

Contents

1 INTRODUCTION

In 1997 IMO adopted a resolution on CO_2 emissions from ships[1].

IMO Assembly further adopted resolution A.963(23) on IMO policies and practices related to the reduction of greenhouse gas emissions from ships, which requests the MEPC to develop a greenhouse gas emission index for ships, and guidelines for use of that index.

This document constitutes the guidelines for the use of an Energy Efficiency Operational Indicator (EEOI) for ships. It sets out:

- what the objectives of the IMO CO_2 emissions indicator are,
- how a ship's CO_2 performance should be measured, and
- how the index could be used to promote low-emission shipping, in order to help limit the impact of shipping on global climate change.

2 OBJECTIVES

The objective of these guidelines is to provide the users with assistance in the process of establishing a mechanism to achieve the limitation or reduction of greenhouse gas emissions from ships in operation.

These guidelines present the concept of an indicator for the energy efficiency of a ship in operation, as an expression of efficiency expressed in the form of CO_2 emitted per unit of transport work. The guidelines are intended to provide an example of a calculation method which could be used as an objective, performance-based approach to monitoring the efficiency of a ship's operation.

These guidelines are recommendatory in nature and present a possible use of an operational indicator. However, shipowners, ship operators and parties concerned are invited to implement either these guidelines or an equivalent method in their environmental management systems and consider adoption of the principles herein when developing plans for performance monitoring.

3 DEFINITIONS

3.1 Indicator definition

In its most simple form *the Energy Efficiency Operational Indicator* is defined as the ratio of mass of CO_2 (M) emitted per unit of transport work:

Indicator = M_{CO_2} / (transport work)

For more details of indicator calculation see 3.2 to 3.4 and Appendix 1.

[1] Resolution 8 of the 1997 International Conference of Parties to MARPOL 73/78.

3.2 Fuel consumption

Fuel consumption, FC, is defined as all fuel consumed at sea and in port or for a voyages or period in question, e.g., a day, by main and auxiliary engines including boilers and incinerators.

3.3 Distance sailed

Distance sailed, means the actual distance sailed in nautical miles (deck log-book data) for the voyage or period in question.

3.4 Ship and cargo types

The guidelines are applicable for all ships performing transport work.

.1 Ships:

- dry cargo carriers
- tankers
- gas tankers
- container ships
- ro-ro cargo ships
- general cargo ships
- passenger ships including ro-ro passenger ships

.2 Cargo:

Cargo includes but not limited to:
all gas, liquid and solid bulk cargo, general cargo, containerized cargo (including the return of empty units), break bulk, heavy lifts, frozen and chilled goods, timber and forest products, cargo carried on freight vehicles, cars and freight vehicles on ro-ro ferries, and passenger (for passenger and ro-ro passenger ships)"

3.5 Cargo Mass Carried or Work Done

In general, cargo mass carries or work done is expressed as follows:

.1 for dry cargo carries, liquid tankers, gas tankers, ro-ro cargo ships and general cargo ships, metric tonnes (*t*) of the cargo carried should be used;

.2 for container ships carrying solely containers, number of containers (TEU) or metric tons(*t*) of the total mass of cargo and containers should be used;

.3 for ships carrying a combination of containers and other cargoes, a TEU mass of 10 t could be applied for loaded TEUs and 2 t for empty TEUs; and

.4 for passenger ships including ro-ro passenger ships, number of passengers or gross tonnes of the ship should be used;

In some particular cases, work done can be expressed as follows:

.5 for car ferries and car carriers, number of car units or occupied lane metres;

.6 for container ships, number of TEUs (empty or full); and

.7 for railway and ro-ro vessels, number of railway cars and freight vehicles, or occupied lane metres.

For vessels such as, for example, certain ro-ro vessels which carry a mixture of passengers in cars, foot passengers and freight, operators may wish to consider some form of weighted average based on the relative significance of these trades for their particular service.

3.6 Voyage

Voyage means the period between a departure from a port and the arrival at the next port. Period from the arrival at the port until the next departure can be included in the voyage or, alternatively, EEOI during the stay in the port can be calculated separately.

4 ESTABLISHING AN ENERGY EFFICIENCY OPERATIONAL INDICATOR (EEOI)

The EEOI should be a representative value of the energy efficiency of the ship operation over a consistent period which represents the overall trading pattern of the vessel. Guidance on a basic calculation procedure for a generic EEOI is provided in the Appendix.

In order to establish the EEOI , the following main steps will generally be needed:

.1 define the period for which the EEOI is calculated*;

.2 define data sources for data collection;

.3 collect data;

.4 convert data to appropriate format; and

.5 calculate EEOI.

* Ballast voyages, as well as voyages which are not used for transport of cargo, such as voyage for docking service, should also be included. Voyages for the purpose of securing the safety of a ship or saving life at sea should be excluded.

5 GENERAL DATA RECORDING AND DOCUMENTATION PROCEDURES

Ideally, the data recording method used should be uniform so that information can be easily collated and analysed to facilitate the extraction of the required information. The collection of data from ships should include the distance travelled, the quantity and type of fuel used, and all fuel information that may affect the amount of carbon dioxide emitted. For example, fuel information is provided on the bunker delivery notes that are required under regulation 18 of MARPOL Annex VI.

If the example formula given in the Appendix is used, then the unit used for distance travelled and quantity of fuel should be expressed in nautical miles and metric tonnes. The work done can be expressed using units appropriate for the ship type in paragraph 3.5.

It is important that sufficient information is collected on the ship with regard to fuel type and quantity, distance travelled and cargo type so that a realistic assessment can be generated.

The distance travelled should be calculated by actual distance travelled, as contained in the ship's log-book.

Amount and type of fuel used (bunker delivery notes) and distance travelled (according to the ship's log-book) could be documented by the ship based either on the example described in the Appendix or on an equivalent company procedure.

6 MONITORING AND VERIFICATION

6.1 General

Documented procedures to monitor and measure, on a regular basis, should be developed and maintained. Elements to be considered when establishing procedures for monitoring could include:

- identification of operations/activities with impact on the performance;
- identification of data sources and measurements that are necessary, and specification of the format;
- identification of frequency and personnel performing measurements; and
- maintenance of quality control procedures for verification procedures.

The results of this type of self-assessment could be reviewed and used as indicators of the System's success and reliability, as well as identifying those areas in need of corrective action or improvement.

It is important that the source of figures established are properly recorded, the basis on which figures have been calculated and any decisions on difficult or grey areas of data. This will provide assistance on areas for improvement and be helpful for any later analysis.

In order to avoid unnecessary administrative burdens on ships' staff, it is recommended that monitoring of an EEOI should be carried out by shore staff, utilizing data obtained from existing required records such as the official and engineering logbooks and oil record books etc. The necessary data could be obtained during internal audits under ISM, routine visits by superintendents, etc.

6.2 Rolling average indicator

As a ship energy efficiency management tool, the rolling average indicator should be calculated by use of a methodology whereby the minimum period of time or a number of voyages that is statistically relevant is used as appropriate. "Statistically relevant" means that the period

set as standard for each individual ship should remain constant and be wide enough so the accumulated data mass reflects a reasonable mean value for operation of the ship in question over the selected period.

7 USE OF GUIDELINES

Methodology and use of EEOI, as described in this guideline, provides an example of a transparent and recognized approach for assessment of the GHG efficiency of a ship with respect to CO_2 emissions. The guidelines are considered to be suitable for implementation within a company environmental management system.

Implementation of the EEOI in an established environmental management system should be performed in line with the implementation of any other chosen indicator and follow the main elements of the recognized standards (planning, implementation and operation, checking and corrective action, management review).

When using the EEOI as a performance indicator, the indicator could provide a basis for consideration of both current performance and trends over time.

One approach could be to set internal performance criteria and targets based on the EEOI data.

* * *

APPENDIX

Calculation of Energy Efficiency Operational Indicator (EEOI) based on operational data

1 General

The objective of the appendix is to provide guidance on calculation of the Energy Efficiency Operational Indicator (EEOI) based on data from the operation of the ship.

2 Data sources

Primary data sources selected could be the ship log book (bridge log-book, engine log-book, deck log-book and other official records).

3 Fuel mass to CO_2 mass conversion factors (C_F)

C_F is a non-dimensional conversion factor between fuel consumption measured in g and CO_2 emission also measured in g based on carbon content. The value C_F of is as follows:

Type of fuel	Reference	C_F (t-CO_2 / t-Fuel)
1. Diesel/Gas Oil	ISO 8217 Grades DMX through DMC	3.186[1]
2. Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	3.151
3. Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	3.114
4. Liquid Petrol Gas (LPG)	2006 IPCC guidelines Table 1.2 and 3.5.2	2.985[1]
5. Natural Gas	2006 IPCC guidelines Table 1.2 and 3.5.2	2.693[1]

[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 (CO_2 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.

4 Calculation of EEOI

The basic expression for EEOI for a voyage is defined as:

$$\text{EEOI} = \frac{\sum_j FC_j \times C_{Fj}}{m_{cargo} \times D} \qquad \text{Equation 1}$$

Where average of the indicator for a period or for a number of voyage is obtained, the Indicator is calculated as:

$$\text{Average EEOI} = \frac{\sum_i \sum_j (FC_{ij} \times C_{Fj})}{\sum_i (m_{cargo,i} \times D_i)} \qquad \text{Equation 2}$$

where;

- j is the fuel type;
- i is the voyage number;
- FC_{ij} is the mass of consumed fuel j at voyage i;
- C_{Fj} is the fuel mass to CO_2 mass conversion factor for fuel j
- m_{cargo} is cargo carried (tonnes) or work done (number of TEU or passengers) or gross tonnes for passenger ships; and
- D is the distance in nautical miles corresponding to the cargo carries or work done.

The unit of EEOI depends on the measurement of cargo carried or work done, e.g., tonnes CO_2/(tonnes • nautical miles), tonnes CO_2/(TEU • nautical miles), tonnes CO_2/(person • nautical miles), etc.

It should be noted that Equation 2 does not give a simple average of EEOI among number of voyage i.

5 Rolling average

Rolling average can be calculated in a suitable time period, for example one year closest to the end of a voyage for that period, or number of voyages, for example six or ten voyages, which are agreed as statistically relevant to the initial averaging period. The Rolling Average EEOI is then calculated for this period or number of voyages by Equation 2 above.

6 Data

Data covering a voyage or period, e.g., a day, in question with corresponding data on fuel consumption/cargo carried and distanced sailed for each voyage in a continuous sailing pattern could be collected as shown in the reporting sheet below.

CO_2 Indicator reporting sheet

NAME AND TYPE OF SHIP						
Voyage or day (i)	Fuel consumption (FC) at sea and in port in tonnes				Voyage or time period data	
	Fuel type ( )	Fuel type ( )	Fuel type ( )		Cargo (m) (tonnes or units)	Distance (D) (NM)
1						
2						
3						

NOTE: For voyages with m_{cargo} =0, it is still necessary to include the fuel used during this voyage in the summation above the line.

7 Conversion from g/tonne-mile to g/tonne-km

The CO_2 indicator may be converted from g/tonne-mile to g/tonne-km by multiplication by 0.54.

8 Example:

A simple example including one ballast voyage, for illustration purpose only, is provided below. The example illustrates the application of the formula based on the data reporting sheet.

NAME AND TYPE OF SHIP						
Voyage or day (i)	Fuel consumption (FC) at sea and in port in tonnes				Voyage or time period data	
	Fuel type (HFO)	Fuel type (LFO)	Fuel type ( )		Cargo (m) (tonnes or units)	Distance (D) (NM)
1	20	5			25000	300
2	20	5			0	300
3	50	10			25000	750
	10	3			15000	150

$$EEOI = \frac{100 \times 3.114 + 23 \times 3.151}{(25{,}000 \times 300) + (0 \times 300) + (25{,}000 \times 750) + (15{,}000 \times 150)} = 13.47 \times 10^{-6}$$

unit: tonnes CO_2/(tons • nautical miles)

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ANNEX 2

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.

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