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PREVENTION OF AIR POLLUTION FROM SHIPS

The Energy Efficiency Design Index (EEDI) and Life Cycle Considerations

Submitted by Greece

SUMMARY	
Executive summary:	This document explains the position of Greece as regards life cycle aspects of the Energy Efficiency Design Index (EEDI)
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.1 and 7.3.1.3
Action to be taken:	Paragraph 18
Related documents:	MEPC 59/4/20; MEPC.1/Circ.681, MEPC.1/Circ.682; MEPC 59/WP.8 and MEPC 59/24

Introduction

1 MEPC 59 agreed to circulate the interim Guidelines on the method of calculation of the Energy Efficiency Design Index (EEDI) for new ships (MEPC.1/Circ.681) and the interim Guidelines for voluntary verification of EEDI (MEPC.1/Circ.682).

2 This document is submitted in accordance with MSC-MEPC.1/Circ.2, Guidelines on the organization and method of work, and makes some additional observations on the EEDI which are, in Greece's opinion, important. The main thrust of this document has to do with the need for the inclusion of the notion of "life cycle" emissions of ships in the EEDI formula.

Life cycle considerations

3 The EEDI is supposed to be a "strategic" index, that is, intended to be used in the design phase of the ship. As such, it should capture the main attributes of a ship's environmental performance over its entire life cycle, that is, on a "cradle-to-grave" basis. This is in contrast to the Energy Efficiency Operational Indicator (EEOI), which is only defined on an operational basis.

4 However, the current definition of the EEDI, in both the detailed formula and its simplified form, does not take into account emissions generated outside the ship's operational lifetime, such as during the shipbuilding and recycling phases, among others. For instance, a ship built with thicker corrosion margins than another ship of the same displacement, speed and power would have a lower deadweight, and, as such, would have a higher EEDI value. In that sense, the more robust ship would appear less environment-friendly than its less robust counterpart. Yet, it is not widely known that the stronger ship might produce less CO_2 through its life cycle, if emissions during the shipbuilding, repair and recycling phases are also taken into account. This could result in a less robust ship having a more favourable EEDI than the more robust one, even though the total CO_2 generated during the less robust ship's life cycle is higher.

5 To illustrate this issue, Greece would like to cite the results of a recent study (Gratsos *et al.*, 2009)[1], which indicated that ships built with thicker corrosion allowances may achieve lower life cycle CO_2 emissions. In addition to those operational emissions generated by burning fuel at sea or in port, CO_2 emissions associated with a ship's life cycle include those produced by the following activities:

- Steel fabrication
- Shipbuilding
- Repairs
- Recycling
- Transport of raw materials and steel.

6 None of the CO_2 emissions associated with these activities is captured by the EEDI formula. This means that a ship whose life cycle CO_2 emissions are higher than those of another ship may achieve a lower (more favourable) EEDI nonetheless.

7 The study in question compared the life cycle CO_2 emissions of two Panamax and two Handymax bulk carriers built to two different design concepts. In either case, ship A is built according to the concept of low initial cost, lighter lightship weight, in order to maximize cargo carrying capacity, with corrosion margins according to IACS's new Common Structural Rules Final Version (CSR). Ship B is a ship of identical form and displacement to ship A, but with a higher lightship weight due to greater corrosion allowances and particularly so in selected areas commensurate with present industry experience in order to minimize steel renewals. Ship B has overall similar corrosion margins with the pre-CSR ships (typically equivalent to 20-25% of original plate thickness) with further increases in some areas where these pre-CSR margins had proved inadequate (such as bulk carrier hold frames, lower transverse bulkheads, ballast tank scantlings, etc.).

8 The ships are otherwise identical, having similar coatings, materials, operation and maintenance policies and are assumed to be employed in similar trading patterns. Ship speeds are also the same, and the study required that both ship types produce the same amount of transport work (expressed in tonne-kms) in a year. After calculations to account for different payloads and different operational days per year, the net implication is that more ships of type A would be required so that total annual tonne-km are the same (the fraction is on the order of 1.5%).

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[1] Gratsos, G.A., H. N. Psaraftis, P. Zachariadis (2009), "Life cycle cost of maintaining the effectiveness of a ship's structure and environmental impact of ship design parameters: an update", *RINA Conference on the Design and Operation of Bulk Carriers*, Athens, Greece, Oct. 26-27, 2009. Available at http://www.martrans.org/documents/2009/air/LIFE.CYCLE.FINAL.pdf

9 Table 1 compares operational CO_2 emissions between ship A and ship B (Panamax case). A common "super-life cycle" of 60 years is assumed as the least common multiple of the 20-year life cycle of ship A, which is limited for financial considerations because of repairs, and the 30-year life cycle of ship B. There will be three cycles of ship A and two cycles of ship B within this period (see Gratsos *et al.*, 2009 for details).

Table 1: Operational CO_2 emissions, Panamax ship

	Ship A	Ship B
Operating days/yr	351	359
Displacement (tonnes)	84,400	84,400
Lightship (tonnes)	11,400	12,200
Idle days/yr (avg.)	14	6
Payload (40% light cargoes, tonnes)	70,900	70,420
Average speed (knots)	13.30	13.30
Sea days (% of op. days)	70	70
SEA days/yr	245.70	251.30
PORT days/yr	105.30	107.70
Capacity utilization	0.65	0.65
SEA kms/yr	145,248	148,558
Tonne-kms/yr	6,693,736,516	6,799,950,182
Bunkers SEA (T/day) HFO	33.00	33.00
Bunkers port (T/day) HFO	2.50	2.50
Total bunkers SEA/yr HFO	8,108	8,293
Total bunkers PORT/yr HFO	263	269
Total bunkers/yr (tonnes)	8,371	8,562
CO_2 coef	3.021	3.021
CO_2, SEA/yr	24,495	25,053
CO_2, PORT/yr	795	813
TOTAL CO_2/yr (tonnes)	25,290	25,866
Grams of CO_2/Tonne-km	3.778	3.804
Total bunkers/yr (tonnes)	8,504	8,562
CO_2/yr (tonnes)	25,691	25,866
SUBTOTAL 1, CO_2 in 60 yrs (tonnes)	1,541,468	1,551,975

10 As expected, the life cycle environmental performance of ship A is better than that of ship B, but **if CO_2 only due to fuel burned through the ship's lifetime operation is taken into account**. The difference amounts to less than 600 tonnes of CO_2 per ship per year, but it is still a positive difference in favour of ship A.

11 However, this only accounts for the operational phase of a ship's lifetime. Tables 2 and 3 display CO_2 emissions due to other activities associated with a ship's life cycle, such as steel fabrication, shipbuilding, repairs and recycling (see Gratsos *et al.*, 2009 for details).

Table 2: Various other CO_2 emissions for Panamax ship

Steel fabrication	Ship A	Ship B
Lightship (tonnes)	11,400	12,200
Replacement steel (tonnes)	1,700	900
Total (tonnes)	13,100	13,100
Total steel in 60 years (tonnes)	39,746	26,200
CO_2 steel fabrication coef	1.750	1.750
CO_2 in 60 yrs due to steel fabrication (tonnes)	69,555	45,850
Shipbuilding		
Total steel in 60 years (tonnes)	39,746	26,200
CO_2 shipbuilding coef	0.216	0.216
CO_2 in 60 yrs due to shipbuilding (tonnes)	8,585	5,659
Repairs		
CO_2 repair coef	0.303	0.303
Steel renewed in 60 yrs (tonnes)	5,100	1,800
CO_2 in 60 yrs due to repairs (tonnes)	1,563	545
Recycling		
CO_2 recycling coef	0.18	0.18
Steel scrapped in 60 yrs (tonnes)	34,200	24,400
CO_2 in 60 yrs due to recycling (tonnes)	6,226	4,392
SUBTOTAL 2, CO_2 in 60 yrs (tonnes)	1,627,398	1,608,422

Table 3: CO_2 emissions from the transport of raw materials and steel, Panamax ship

Transport of raw materials and steel	Ship A	Ship B
Lightship steel needed in 60 yrs (tonnes)	39,746	26,200
Steel renewed in 60 yrs (tonnes)	5,158	1,800
Total steel in 60 years (tonnes)	44,904	28,000
Raw materials factor	2.66	2.66
Raw materials for total steel (tonnes)	119,444	74,480
Average distance (km)	6,452	6,452
Tonne-kms for raw materials	770,654,413	480,544,960
Grams CO_2 per tonne-km of ship to transport raw materials or steel	4.00	4.00
Tonnes CO_2 for raw materials	3,083	1,922
Average distance (km) for scrap	7,760	7,760
Tonne-kms for scrap	308,428,837	203,312,000
Tonnes CO_2 for scrap	1,234	813
TOTAL CO_2 for transport of raw materials and steel (tonnes)	4,316	2,735
TOTAL CO_2 **in 60 yrs (tonnes)**	1,631,714	1,611,157
TOTAL CO_2 **per year (tonnes)**	27,195	26,853

12 One can see that ship B is better than ship A in terms of total CO_2 produced during a ship's life cycle, by an average of 342 tonnes of CO_2 per year. Similar results apply to the Handymax case study. Even though these results seem to be marginal on a per ship basis (a difference on the order of 1% between ship A and ship B), they can be substantial overall if one takes into account the number of ships in the fleet. In 2007, and according to the Lloyds-Fairplay ship database, there were some 1,383 Panamax ships and some 1,732 Handymax ships in the world fleet (among a total of 6,462 dry bulk carriers).

13 The study showed that for both these sizes total CO_2 emissions in a ship's life cycle are some percentage higher than operational CO_2 emissions alone, even though the real level of non-operational emissions has been purposely underestimated in the study and these are likely to he higher. Just for these two ship sizes, and based on the sizes of the current fleet, operating ships of type A would produce some 790,000 tonnes of CO_2 per year more than if ships of type B were used instead. 790,000 tonnes is not a negligible quantity (almost 0.1% of the total annual CO_2 emissions from shipping). As world fleet current operational CO_2 emissions are estimated on the order of a billion tonnes per year[2], five to six per cent is some 50-60 million tonnes of additional CO_2 per year, to the extent the same percentage is true globally. Similarly, 1% (the difference between ship A and ship B), to the extent it is also true for other ship types and sizes, is a reduction of some 10 million tonnes of CO_2 per year. These may be small percentages, but worthy of note in absolute terms.

14 Note that other activities, such as mining of raw materials, paints used on the ship and others would also produce emissions but were not considered. Doing so would further tilt the results in favour of ship B.

15 Still, a comparison of the EEDI values for these ships would yield exactly the opposite result, as indicated in Table 4. The following simplified formula was used to compute the EEDI values:

$$EEDI = 3.13(190P_{ME}+210P_{AE})/(DWT \cdot V), \text{ where}$$

$P_{ME} = 0.75MCR$
$P_{AE} = 0.025MCR + 250$ if $MCR \geq 10{,}000$ kW
$P_{AE} = 0.05MCR$ if $MCR < 10{,}000$ kW
V = service speed corresponding to 75% of MCR.

Table 4: EEDI comparison

PANAMAX	Ship A	Ship B
75% of MCR (kW)	6,750	6,750
Speed at 75% MCR	13.30	13.30
DWT	73,000	72,200
EEDI	4.439	4.488

HANDYMAX	Ship A	Ship B
75% of MCR (kW)	5,732	5,732
Speed at 75% MCR	13.30	13.30
DWT	46,500	45,900
EEDI	5.918	5.996

[2] MEPC 58/INF.6: "Updated Study on Greenhouse Gas Emissions from Ships: Phase I Report": Buhaug, Ø., J.J. Corbett, Ø. Endresen, V. Eyring, J. Faber, S. Hanayama, D.S. Lee, D. Lee, H. Lindstad, A. Mjelde, C. Pålsson, W. Wanquing, J.J. Winebrake, K. Yoshida, (2008).

16 One can see that in terms of the EEDI value, ship A is better than ship B for both designs. This is solely due to the difference in DWT between the two ships. But this also means that a ship whose life cycle CO_2 emissions are higher is better on paper, as its EEDI value is lower.

Conclusions

17 In Greece's opinion, the EEDI formula should be adjusted so that ships built according to more robust specifications, whether due to future regulations (GBS) or voluntarily by owners, are not unduly penalized, because they do not emit substantially more CO_2 in total (construction, operation and maintenance) within their Life Cycle. Note also that these more robust ships would also be better from a safety viewpoint. It is reminded that the intersessional GHG Working Group had agreed that "*safety should not be compromised in seeking environmental protection*" (MEPC 59/WP.8, paragraph 6.23). Also at least one more delegation has argued that more robust and safer ships (CSR and in the future GBS) should not be penalized due to their increased safety (see document MEPC 59/4/20 by China). With the present submission, Greece argues that such ships may also emit less CO_2 over their lifetime.

Action required of the Committee

18 The Committee is invited to consider the information in this document; in particular, to consider adjusting the EEDI formula to account for ships built to more robust specifications, and take action as appropriate.

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