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PREVENTION OF AIR POLLUTION FROM SHIPS

Comments on the coefficient "f_w" in the EEDI formula

Submitted by China

SUMMARY

Executive summary:	This document provides comments on the coefficient "f_w" in the draft interim guidelines on the method of calculation of the Energy Efficiency Design Index for new ships which is included in document MEPC 59/4/2, annex 2
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 11
Related documents:	GHG-WG 2/2/11, GHG-WG 2/2/15, GHG-WG 2/WP.1 and MEPC 59/4/2

Introduction

1 This document is submitted in accordance with the provisions of paragraph 4.10.5 of the Guidelines on the organization and method of work of the MSC and MEPC and their subsidiary bodies (MSC-MEPC.1/Circ.2).

2 At GHG-WG 2, the draft interim guidelines on the method of calculation of the energy efficiency design index was considered and modified (see MEPC 59/4/2, annex 2). The regulations regarding weather factor f_w remains unchanged, that is, f_w value can be determined by conducting the ship-specific simulation of its performance in representative sea conditions or be taken from the "Standard f_w" table/curve, and should be taken as one (1.0) until the Guidelines of the two methods above becomes available.

3 China pointed out in its document GHG-WG 2/2/11 some concerns about coefficient f_w and aspects to be considered carefully, especially that coefficient f_w should be set on the basis of reasonable and universal applicability. After GHG-WG 2, China studied coefficient f_w in more depth and brings forward further comments and proposals on considerations of f_w.

Considerations

4 Baufort Scale 6 is recommended as the representative sea conditions in the draft interim guidelines on EEDI. At GHG-WG 2, it was noted (GHG-WG 2/WP.1, paragraph 2.31.2) that the weather conditions of winter North Atlantic under IMO GBS should be considered as reference for f_w. In order to illustrate the difference of f_w on different sea conditions, China calculated f_w values for a container ship and an oil tanker based on data from ship model tests of calm water resistance and propeller properties as well as wave resistance. The results are shown in table 1 for a 1,400 TEU container ship and in table 2 for a 100,000 DWT oil tanker.

Table 1 – f_w of a 1,400 TEU containership

Beaufort scale	significant wave height $H_{1/3}$(m)	Mean wave period T(s)	Wind speed （m/s）	f_w
BF4	1	3.9	6.7	0.990
BF5	2	5.5	10	0.984
BF6	3	6.7	12.6	0.965
BF7	4	7.7	15.5	0.925
BF8	5.5	9.1	19	0.817

Table2 – f_w of a 100,000 DWT oil tanker

Beaufort scale	significant wave height $H_{1/3}$(m)	Mean wave period T(s)	Wind speed （m/s）	f_w
BF4	1	3.9	6.7	0.972
BF5	2	5.5	10	0.951
BF6	3	6.7	12.6	0.908
BF7	4	7.7	15.5	0.815
BF8	5.5	9.1	19	/

5 It is clearly shown from the two tables that the value of f_w is obviously influenced by the selection of sea conditions. However ships are operated in different sailing areas and different sea conditions, to select BF6 or the North Atlantic condition as the basis of f_w is not universal applicable and will lead to either bigger or smaller value of f_w. This will not reflect the real energy efficiency of different ships.

6 Japan proposed a calculation method for wave resistance in its document GHG-WG 2/2/15 where the added wave resistance is divided into two parts; one is based on ship motions and the other on short wave diffraction. It is well known that ship motion induced added resistance is the absolute parts at moderate sea condition, so the accuracy of calculation of the ship motion induced added resistance has remarkable influence on the value of fw. Nevertheless, the recommended method in document GHG-WG 2/2/15 and the calculation software provided by NMRI only utilize three parameters (ship section breadth, section draft and the area of the cross section) to determine ship hydrodynamic coefficients, which are not sensitive to the ship hull form variation. This method may result in different ships with the same parameters to have the same added wave resistance, which can not reflect the influence of different hull design on the value of f_w.

7 It was proposed in document GHG-WG 2/2/15 that the forward speed effect in the short wave diffraction resistance may be modified by a linear relationship with the corresponding Froude number. China carried out studies on the forward speed coefficient Cu and found it has significant influence on the value of f_w. The calculation results for five ships are summarized in table 3.

Table 3 – The influence of Cu on the value of f_w

Cu	f_w				
	1400TEU	NMRI-CONT	59000 BC	NMRI-PXBC	100000 Tank
0	0.9460	0.9560	0.8919	0.9072	0.9458
5	0.9330	0.9500	0.8566	0.8767	0.9190
10	0.9210	0.9434	0.8230	0.8473	0.8781
15	0.9200	0.9431	0.7910	0.8193	0.8460
20	0.9180	0.9426	0.7600	0.7929	/
25	0.9160	0.9373	0.7300	0.7676	/
30	0.9120	0.9430	0.7010	/	/
35	0.9090	0.9398	/	/	/
40	0.9040	0.9373（43.5)	/	/	/

These data clearly shows that coefficient Cu is very sensitive to f_w, especially for blunt ships like tankers and bulk carriers, where Cu determines the f_w value directly. Further studies on the relationship of forward speed and diffraction resistance were carried out consequently based on the data of model tests, and a nonlinear relationship was found, therefore the linear dependence relation proposed in GHG-WG 2/2/15 is not suitable for all ships which will magnify the influence of Cu.

8 The calculation method of added wave resistance proposed in GHG-WG 2/2/15 is not sensitive to the modification of ship hull form, and there is a large deviation of calculation accuracy for blunt ships and slender ships. It can not reflect the utilization of anti-rolling devices and also does not consider the influence of sea conditions on the propeller.

9 In the present proposal the baseline of the EEDI are calculated based on calm water speed without consideration of weather effects, while the attained EEDI of ships are calculated using f_w. This will lead to an unreasonable comparison and assessment of EEDI performance of the ship. If f_w is to be included in the EEDI formula, the baseline must be built on the basis of the specified sea condition using the same sampled ships (from the Fairplay database) for the sake of fairness.

Comments and proposals

10 In light of the information provided in paragraphs 4 to 8 above, China is of the view that influencing factors on *fw* are much more complicated than assumed conditions in ship design and that it is nearly impossible to obtain the baseline based on the weather effects mentioned in paragraph 8. Therefore China provides the following proposals:

.1 The coefficient f_w should be removed from the EEDI formula, because the baseline is based on calm water speed, comparison of the attained EEDI of a ship should, therefore, also be based on calm water speed; and

.2 Once f_w is kept in the EEDI formula, the required EEDI of ships and the relevant guidelines for f_w must be developed in accordance with the following requirements:

- due to the sensitivity of the f_w value to different sea conditions, the establishment of representative sea conditions should be based on actual voyage data. A weighting factor corresponding to different sea conditions should be given to different sea zones for the individual vessel;

- more theoretical and experimental research work should be encouraged to establish a simulation method applicable to different types of ships, especially to energy-saving ships. The evaluation method for active speed loss in rough sea should also be developed; and

- the standard curve/table of f_w should be established using the same sampled ships from Fairplay database as those used for the establishment of the baselines of the EEDI.

Action requested of the Committee

11 The Committee is invited to consider the above information and proposals and take action as appropriate.

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