INTERNATIONAL MARITIME ORGANIZATION

IMO

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
58th session
Agenda item 4

MEPC 58/4/29
15 August 2008
Original: ENGLISH

PREVENTION OF AIR POLLUTION FROM SHIPS

Draft "standard f_w" curves for the new ship design CO_2 index

Submitted by Japan

SUMMARY

Executive summary:	This document provides draft "standard f_W" curves to obtain the coefficient "f_W" without conducting the simulation of ship performance in the new ship design CO_2 index
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 4
Related documents:	MEPC 57/4/3, MEPC 57/4/11, MEPC 57/4/12, MEPC 57/INF.12 and MEPC 58/4, paragraph 2.23 and annex 5

Introduction

1 This document provides comments on document MEPC 58/4 and is submitted in accordance with paragraph 4.10.5 of the Committees' Guidelines (MSC-MEPC.1/Circ.2).

2 The Draft Guidelines on the Method of Calculation of the New Ship Design CO_2 Index contain the coefficient "f_W", which represents speed reduction in actual sea conditions. The "f_W" coefficient can be determined either by conducting simulation of ship performance in the representative sea conditions or by taking the default f_W value from the "standard f_W" curve in case the simulation is not conducted (paragraph 9 of annex 5 to document MEPC 58/4).

3 The annex to this document provides draft "standard f_W" curves, which are to be included in the Guidelines. The standard curves are developed by ship type and expressed as a function of the capacity parameter used, e.g., DWT. The draft "standard f_W" curves are prepared by a conservative approach, i.e. based on data of actual speed reduction, of as many existing ships as possible to date, under the representative sea conditions (Beaufort 6).

Action requested of the Committee

4 The Committee is invited to consider the draft "standard f_W" curve set out in the annex to this document and take action as appropriate.

***

ANNEX

DRAFT "STANDARD f_W" CURVES FOR THE NEW SHIP DESIGN CO_2 INDEX

1 This annex provides the draft "standard f_W" curves calculated on the basis of main ship particulars and operation data of approximately 170 existing ships in operation. The procedures followed in the calculation are given below.

2 The f_W coefficient has been obtained for individual existing ships, by selecting the data that meet certain conditions as explained below.

3 The calculation resulted in two "standard f_W" curves: 1) for container ships / PCC, and 2) tankers/bulk carriers (see appendix to this document). It has been confirmed that both curves can generally serve as "standard", by comparing them with the f_W values calculated for new ships.

4 We have been in continuous pursuit of additional data in the interests of enhanced accuracy for the "standard f_W" curves. Therefore, the supply of operation records of existing ships from IMO Member States and other interested parties would be appreciated. We intend to report to the Committee with updated results as soon as analyses of the data have been completed. Until such further analysis is given, the proposed "standard *fw*" curve (specific figures contained in the formula presented in the appendix) should be treated as provisional ones.

The procedures for deriving "standard f_W"curves

The procedures for calculating the "standard f_W"curves comprise the following five steps:

STEP 1: To extract data from the ship particulars
The data needed for calculation are Displacement, Speed, Main Engine Output in Horse Power as well as RPM in NOR.

STEP 2: To extract data from the Abstract Log
The data required are Displacement, Wind Direction (WDIR), Observed Beaufort Scale (WFOR), Measuring duration of Distlog and DistOG (HP (hours)), Distance Log (Distlog), Distance over the Ground (DistOG), Rotational Speed per minute (RPM) and Shaft Horse Power (SHP(PS)) for every 24 hours.

The data for calculation of f_W of individual ships are subject to screening, by following the procedures provided from (i) to (v). The data meeting all the criteria provided from (i) to (v) are to be used.

(i) Displacement should be within ±15% of average displacement of the voyages which have been reported to be close to the fully loaded condition[1]. In case where displacement is not available, the average of draft may be used instead of the displacement.

(ii) Wind direction (WDIR): Heading (relative wind direction not exceeding ±67.5 degree).

[1] In reality, it is impossible to collect only the data which are under completely fully load condition.

(iii) Beaufort Scale (WFOR) for the selected data should be 2, 3, 4 or 6.

The data under WFOR 2 ,3 and 4 are used to represent the calm sea condition (no wind and no waves), and the data under WFOR 6 are used to represent the actual sea condition.

(iv) The RPM (Rotational speed per minute) should be within ±5% of the average RPM on voyage.

(v) Distlog should be used under the conditions that difference between DistOG and Distlog is within ±10 % of whichever is smaller.

STEP 3:
3-1 Calibration of the data to reflect the difference between the designed condition and the actual operation.

Distlog data selected in STEP 2 are calibrated by the following equation, in order to take into account the difference between the designed condition and the actual operation in terms of displacement and SHP:

$$V_1 = V_0\left[\left(\frac{\nabla_0}{\nabla_{average}}\right)^{\frac{2}{3}}\right]^{\frac{1}{3}}, \qquad V_2 = V_1\left(\frac{SHP_{design}}{SHP_0}\right)^{\frac{1}{3}}$$

where:

$\nabla_{average}$: Average displacement on the reported voyages SHP_{design} : Output at design stage
∇_0 : Displacement in measurement SHP_0 : Output in measurement
V_0 : Measured ship speed relative to water (Distlog/HP)
V_1 : Calibrated velocity based on displacement
V_2 : Calibrated velocity based on output

3-2 Calculation of V_2 corresponding to calm sea:

30% largest values of V_2 under Beaufort 2, 3 and 4 are extracted to represent the calm sea condition.

3-3 Calculation of V_2 corresponding to BF6:

V_2 for BF6, being affected by the scattered wind/wave direction, are calculated into the values under the heading wind and waves, in accordance with established methods used at sea trials, e.g., ISO 15016.

STEP 4: Calculation of fw for individual existing ships
f_W for a ship = average of V_2 corresponding to BF6 / average of V_2 corresponding to calm sea.

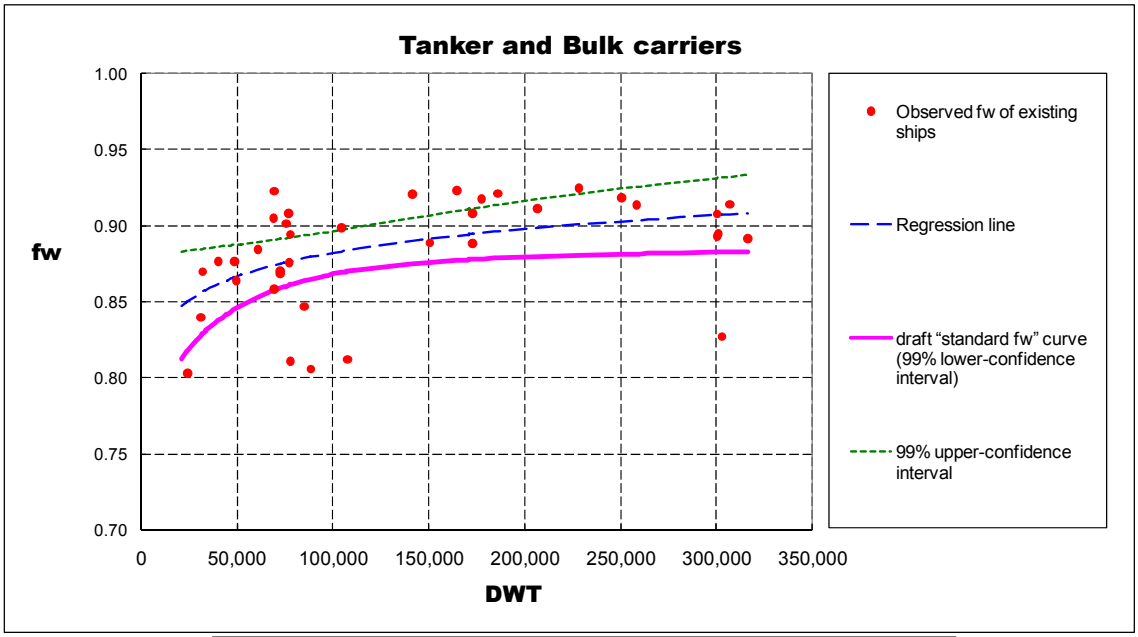
STEP 5: Development of "standard f_W" curve

Run the regression, based on the natural logarithmic function, on those f_W values obtained by STEP 4.

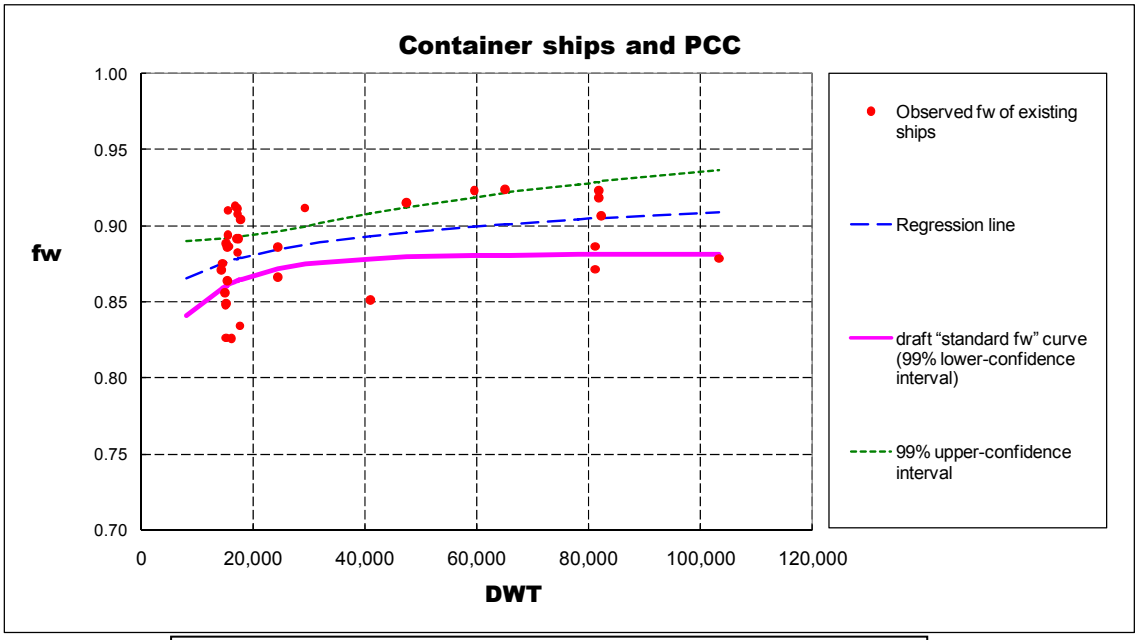
Regression line, in the form of natural logarithmic line, is obtained from the observed f_W values calculated in the above steps and the DWT of each ship. When a particular value of DWT is given, the estimated average f_W of ships having such DWT would lie between the lower limit and the upper limit of the confidence interval as shown in the Appendix, with the probability of 99%. It is proposed that the draft "standard f_W" curve is set to be such 99% lower-confidence interval, based on the conservative approach. In this way, we can avoid the risk that a ship having chosen to conduct the simulation to obtain its f_W value could be put at a disadvantage compared to a ship simply taking the f_W value from the "standard f_W" curve[2].

[2] Another reason to propose the 99% lower-confidence interval as "standard f_W" curve is that the observed f_W values obtained by afore-mentioned calculation steps are likely to be higher than "true" f_W values of existing ships, due to the limitation on the data availability. For example, the denominator of f_W should be the speed at a calm sea condition, however, such speed cannot be obtained from the operation records, therefore, as explained in Step 3-2, the speed under BF 2, 3 and 4 (not completely calm sea) was used, as a proxy to the speed at calm sea. Such approximation may result in higher values of observed f_W, thus higher position of regression line.

APPENDIX



Draft "standard f_W" curve for tanker and bulk carriers
$f_W = 0.02423\ln(\text{DWT}) + 0.5830$



Draft "standard f_W" curve for container ships and PCC
$f_W = 0.01256\ln(\text{DWT}) + 0.7413$

Note: Based on further analysis, "standard f_W" curve for PCC may be developed separately.