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ENERGY EFFICIENCY OF SHIPS

Draft amendments to MEPC.1/Circ.815 additional to the amendments proposed by MEPC 76/6/2, concerning the calculation of the wind propulsion system force matrix and the extension of the scope of that circular to the EEXI

Submitted by France

SUMMARY

Executive summary:	The present document proposes amendments to the *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI* (MEPC.1/Circ.815) additional to those already proposed in MEPC 76/6/2, consisting of the consolidation of the calculation of the wind propulsion system force matrix and the extension of the scope of that circular to EEXI
Strategic direction, if applicable:	3
Output:	3.2 and 3.5
Action to be taken:	Paragraph 11
Related documents:	MEPC.1/Circ.815; MEPC 76/6/2, MEPC 76/6/7

Introduction

1 The *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI* (MEPC.1/Circ.815) was the subject of amendments proposed by MEPC 76/6/2 (Germany et al.) aiming to finalize the Guidance, both by incorporating the global wind probability matrix and by improving the technical recommendations for the performance tests to obtain the wind propulsion system force matrix.

2 The present document, in conjunction with MEPC 76/6/7, proposes amendments to the Guidance, additional to those already proposed in MEPC 76/6/2, consisting of the consolidation of the calculation of the wind propulsion system force matrix in section 2.4.3 of the Guidance and the extension of its scope to the EEXI.

Proposed amendments to consolidate the calculation of the wind propulsion system force matrix

Inclusion of the concept of relative wind and the calculation of the average power consumption coefficient of the wind propulsion system

3 The proposed amendments in the annex to MEPC 76/6/2 concerning the calculation of the of the wind propulsion system force matrix (section 2.4.3) are a very useful addition to the 2013 Guidance.

4 However, in order to further improve this calculation, and in particular to clarify and facilitate consideration of the effect of altitude on the wind force perceived by the wind propulsion system, it is proposed to include in the calculation method the notion of relative wind, by incorporating new steps in the calculation. These new steps provide a common basis for application by including the definition of the reference altitude and the order and method of calculation, while using the global wind probability matrix proposed in MEPC 76/6/2 as the sole reference basis for wind force.

5 In addition, it is proposed to consolidate consideration of the power demand of the wind propulsion system by additional references to $P(V_{ref})_{i,j}$, allowing a more robust definition of the values on which it depends, and a more direct link to its experimental verification in wind tunnel tests as proposed in MEPC 76/6/7.

6 The proposed amendments to paragraphs 2.4.3.1 and 2.4.3.2 of the 2013 Guidance to achieve this are presented in the annex to the present document.

Consideration of the operational limits of the wind propulsion system and the lateral forces and yawing moments

7 We also believe it necessary to mention the need to match the force matrix with the operational limits of the wind propulsion system imposed by the class rules applied to the system in the context of its certification.

8 In addition, the lateral forces exerted by the system on the vessel and the yawing moment created can affect the performance of the system, and thus the EEDI calculation. In order to validate conformity of the EEDI calculation with the class rules, we propose that these lateral forces and yawing moments be documented by the shipbuilder and observed by the verifier. They can be obtained without additional effort during wind tunnel model tests.

9 The proposed amendments for introducing consideration of the operational limits of the wind propulsion system, consisting of the addition of a section 2.4.3bis, are presented in the annex to the present document following the amended section 2.4.3.

Application of MEPC.1/Circ.815 to the EEXI

10 Finally, should the Committee adopt the inclusion of the Energy Efficiency Existing Ship Index (EEXI) in MARPOL Annex VI, it is proposed that all references in the 2013 Guidance to the EEDI be amended to also include the EEXI. Those two indexes are indeed very similar and the methods for treating innovative energy efficiency technologies specified in the Guidance seem to us to be applicable in the same terms to both indexes.

Action requested of the Committee

11 The Committee is invited to consider the proposed amendments to MEPC.1/Circ.815 contained in the annex to the present document, additional to the amendments proposed in MEPC 76/6/2, and to take such action as it deems appropriate.

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ANNEX

DRAFT AMENDMENTS TO MEPC.1/Circ.815 – Section 2.4.3

Underlined text indicates additions and ~~strikethrough~~ indicates deletions.

Note: In order to make it easier to consider them in addition to the amendments proposed in MEPC 76/6/2, the amendments proposed in the present document have been incorporated into the text of the 2013 Guidance such as would result from the adoption of the amendments proposed in MEPC 76/6/2 in their entirety, without prejudging future decisions of the Committee.

2.4.3 **Calculation of the wind propulsion system force matrix**

2.4.3.1 ~~After determining the ship type and the wind propulsion system, the wind propulsion coefficient of the wind propulsion system *ΔCFx* is a function of the relative wind direction angle of the ship only, which describes the inherent characteristics of the wind-assisted ship.~~

2.4.3.~~2~~1 The wind propulsion coefficients of the ship's wind propulsion system ~~obtained from model tests~~ can be used to predict the wind propulsion system force matrix. Apparent wind is defined as the combination of wind relative to the ground (true wind) and wind created by the ship's velocity. The steps to calculate the wind propulsion system force matrix are as follows:

.1 determine the velocity of the ship V_{ref};

.2 select the average true wind speed as 10 metres ($TWS_{i,j}$*(10m)*) approximately corresponding to terms in $W_{i,j}$, the global wind probability matrix. For example, the average wind speed corresponding to the first wind speed range (0-1 m/s) of the wind probability matrix is approximately selected as 0.5 m/s, the average wind speed corresponding to the second wind speed range (1-2 m/s) is approximately selected as 1.5 m/s, etc.;

.3 ~~according to the corresponding average wind speed, wind direction angle and the velocity of the ship, calculate the relative wind speed $V_{i,j}$ and the relative wind direction angle of the ship~~
according to the corresponding average true wind speed at 10 meters, calculate the relative wind speed $AWS_{i,j}$*(zsystem)* and the relative wind direction angle $AWA_{i,j}$*(zsystem)* at the altitude of the wind propulsion system:

.1 from $TWS_{i,j}$*(10m)*, calculate $TWS_{i,j}$*(zsystem)*: the true wind speed at altitude zsystem is defined by the height above water level of the centre of the wind propulsion system surface or its operating surface. Wind speed formulae as a function of $TWS_{i,j}$*(10m)* and *zsystem* must be accepted by the verifier;

.2 from the true wind direction angle, ship velocity V_{ref} and $TWS_{i,j}$*(zsystem)*, calculate relative wind speed $AWS_{i,j}$*(zsystem)* and the relative wind direction angle of the ship $AWA_{i,j}$*(zsystem)*;

.4 according to the relative wind direction angle $AWA_{i,j}(zsystem)$, and the corresponding relationship between the relative wind direction angle and the wind propulsion coefficient ~~Δ~~*CFx* obtained from the test, calculate the average wind propulsion coefficients $(\cancel{\Delta}C_{Fx})_{i,j}$ of the wind propulsion system corresponding to $W_{i,j}$; and

.5 according to the average wind propulsion coefficient and the average power consumption coefficient of the wind propulsion system, calculate the terms of the wind propulsion system force matrix $F(V_{ref})_{i,j}$ and the wind propulsion system power consumption matrix $P\ (V_{ref})_{i,j}$ of the full-scale ship corresponding to $W_{i,j}$ by following formulae:

$$F(V_{ref})_{i,j} = (\cancel{\Delta}C_{Fx})_{i,j} * (0{,}5\ \rho\ \cancel{V_{i,j}}AWS_{i,j}(zsystem)^2\ \cancel{L^2}S)$$

$$P(V_{ref})_{i,j} = S * ((C_{Power})_{i,j} * 0{,}5\ \rho\ AWS_{i,j}(zsystem)^3)$$

Where:

.1 $(\cancel{\Delta}C_{Fx})_{i,j}$ is the average wind propulsion coefficients corresponding to $W_{i,j}$;

.2 $(C_{Power})_{i,j}$ is the average power consumption coefficients of the wind propulsion system corresponding to $W_{i,j}$;

.~~2~~3 ρ is the average air density in shipping environment, ρ =1.225 kg/m^3;

.~~3~~4 $\cancel{V_{i,j}}AWS_{i,j}(zsystem)$ is the relative wind velocity at the altitude of the wind propulsion system *zsystem* ~~of the full-scale ship~~ corresponding to $W_{i,j}$; and

.~~4~~5 ~~L is the ship length~~ S is the reference area of the wind propulsion system. S is determined by scaling the reference area used to determine the C_{FX} wind propulsion coefficients from the wind tunnel test data.

2.4.3bis Consideration of the operational limits of the wind propulsion system and the lateral forces and yawing moments

2.4.3bis.1 Force $F(V_{ref})_{i,j}$ must be calculated only when it is within the operational domain applicable to the wind propulsion system. These operational limitations can be caused at a minimum by wind conditions or by the total forces generated by the wind propulsion system and applied to the ship.

2.4.3bis.2 $F(V_{ref})_{i,j}$ must be zero for any pair (wind direction; wind force) not in conformity with the operational domain of the wind propulsion system validated by the verifier in the operations manual of the wind propulsion system and the ship.

2.4.3bis.3 The lateral forces exerted by the wind propulsion system on the ship and the resulting yawing moment can affect the performance of the system, and therefore the EEDI calculation. The lateral forces on the ship and the yawing moments applied by the wind propulsion system to the ship must therefore be documented by the shipbuilder and observed by the verifier. They can be obtained without additional effort during the tests described in paragraph 2.4.1 of the present circular.

2.4.3bis.4 Conformity with the operational domain requires that for any pair (wind direction; wind force), and in consideration of the total forces generated by the wind propulsion system (i.e. including lateral forces to the vessel and yawing moments), the strength of the wind propulsion system, the forces at the embedment, and the list of the ship conform with the structural design file and the stability file of the ship, respectively. Where the lateral forces and yawing moment are particularly significant, the verifier may request handling and rudder angle demonstrations to validate conformity with the operational domain.