INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
76th session
Agenda item 6

MEPC 76/6/6
7 April 2021
Original: ENGLISH
Pre-session public release: ☒

ENERGY EFFICIENCY OF SHIPS

Additional draft amendments to MEPC.1/Circ.815 for verification of the wind propulsion system

Submitted by Finland and Germany

SUMMARY

Executive summary:	This document proposes additional suggestions for document MEPC 76/6/2 which proposes draft amendments to *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI* (MEPC.1/Circ.815), based on documents MEPC 62/INF.34 and MEPC 74/5/30, with the aim of incentivizing wind propulsion systems within the EEDI framework
Strategic direction, if applicable:	3
Output:	3.5
Action to be taken:	Paragraph 16
Related documents:	MEPC 62/INF.34; MEPC 74/5/30, MEPC 74/INF.39; MEPC 76/6/2 and MEPC.1/Circ.815

Introduction

1 The proposal to revise the *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI* (MEPC.1/Circ.815), which was submitted as document MEPC 76/6/2, is combining documents MEPC 62/INF.34 and MEPC 74/5/30. Based on the documents, the draft guidance allows for finalization as early as possible. At the same time, the co-sponsors believe that the guidance should be improved even a step further, aiming at incentivizing the wind assistant systems within the EEDI/EEXI framework.

2 The global wind probability matrix is an important element of the calculation methodology and is regarded as technically valid. It allows the application of different wind propulsion systems and different installations on different ships in a transparent and fair way and at the same time reflects global wind availability.

3 The actual design process of each wind propulsion system is varied as it considers the planned routes of a specific ship and the corresponding wind conditions. From this point, it turns out that the consideration of the global wind probability matrix is a distinctly conservative approach as shown in document MEPC 74/INF.39.

4 Route optimization offers an essential additional power saving potential for ships with wind propulsion systems. This includes the optimization of ship course and ship speed regarding actual wind conditions.

5 To elaborate further the justification in paragraph 3, it could be worth mentioning that it is expected that the majority of the future wind propulsion installations will be completed on vessels operating in wind conditions which are more suitable for wind propulsion than the global average.

6 Nonetheless, for the calculation of the available effective power of wind propulsion systems under the EEDI framework, a route specific consideration is unsuitable as such approach avoids comparability. Besides, the effective power needs to be related to the reference speed V_{ref}. Additionally, one should take into account that the EEDI is a tool checked at design stage, before the ship is built, and also the global coverage and fair treatment for ships need to be respected. Therefore, the application of the global wind probability matrix is regarded as the most feasible approach.

7 To overcome the conservative character of the calculation influenced by the high representation of low wind forces on the global basis, the idea to better reflect the real positive effects for wind propulsion systems is to cut-off the low wind forces within the global wind probability matrix and use only one-third of the highest wind forces or alternatively half of the maximum globally available wind forces.

8 The idea to use one-third of the highest wind forces stems from the approach for the evaluation of the significant wave height, H_s (explanation of "significant wave height" is available at https://en.wikipedia.org/wiki/Significant_wave_height). To do so and to give an appropriate incentive for the installation of wind propulsion systems, a simplification and a successive adjustment of the calculation method are provided in proposed amendments as set out in the annex to this document with some refinements explained in paragraphs 7 to 9 and an example of use is provided in paragraphs 10 to 13.

Simplified presentation of the calculation method

9 The separate summation across the rows, i, and the columns, j, is replaced by a single summation across all elements, k, of the matrices. According to the definition of the global wind probability matrix, the total number of rows is m=26 and the corresponding number of columns is n=72. The total number of matrix elements is $m \cdot n = 26 \cdot 72 = 1872$. A factor is inserted into the formula which relates the summation across the matrix elements to the corresponding probability. When adding up all elements of the matrices, the probability becomes 1, the factor is 1 as well and the formula agrees with the one given in document MEPC 76/6/2.

Sorting of matrix elements

10 The element-wise description allows for sorting the matrix elements following a descending order of the force matrix elements. The first matrix element with k=1 corresponds to the maximum force given in the force matrix of the wind propulsion system.

Range of considered matrix elements

11 When all matrix elements are summed up, meaning q=m·n=1872, the resulting available effective power becomes conservative and the value is lower than it should be. Therefore, the range of summation should be restricted to exclude the negative effect of low force elements. At the same time the number of considered elements should be large enough to get a representative description of the wind propulsion system. It is proposed to sum up all elements with the [one-third] [one half] largest force. In this way the average of the largest force elements is calculated which gives a characteristic value for each wind propulsion system and each specific installation on a specific ship.

Exemplary calculation

12 Recently, two Flettner rotors with a height of 35 m and a diameter of 5 m were installed on the 8,660 DWT ro-ro cargo ship MV. SC CONNECTOR. With an installed main diesel engine power of 5,600 kW and the total auxiliary power covered by the shaft generator, the calculated available effective power delivered by the wind propulsion system is 505 kW according to the calculation methodology as given in document MEPC 76/6/2, but [1423 kW] [1008 kW] when the [one-third] [one half] highest values are considered as proposed in this document.

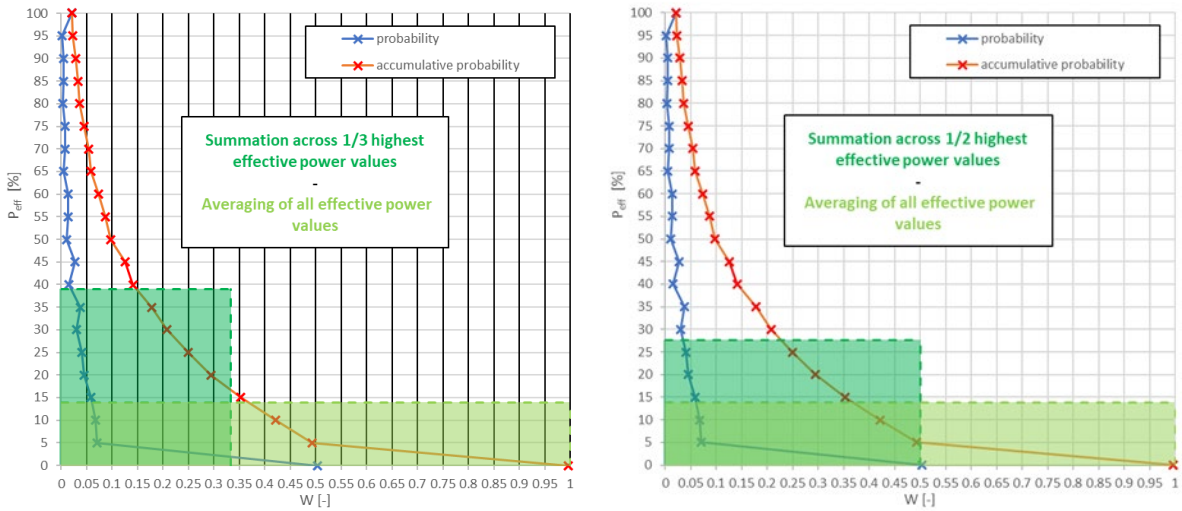

Figure 1: Probability distribution of effective power and available effective power of [one-third] [one half] highest values and of all values.

13 With the installation of the Flettner rotors the attained EEXI value of the ship is improved by 15% according to document MEPC 76/6/2, and by [42%] [30%] when the available effective power is calculated from the [one-third] [one half] highest power values only.

14 A careful prediction of the rotor sails manufacturer estimates a reduction in emissions by 25%. First operational data shows that the vessel is temporarily sailing with 140% of V_{ref} in good winds without main engine propulsion. Based on these data, the owner expects distinctly higher emission reductions than predicted.

15 In accordance with the example of a VLCC with hard airfoil sails given in document MEPC 74/INF.39, the example at hand proves that the calculation according document MEPC 76/6/2 is conservative. Considering only the [one-third] [one half] highest power values gives a more [beneficial] [realistic] result of fuel saving in comparison to the operational estimation.

Action requested of the Committee

16 The Committee is invited to consider the proposed amendments to the *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI* set out in the annex to this document and take action as appropriate.

***

ANNEX

PROPOSED AMENDMENTS TO MEPC.1/Circ.815
(shown as additions/~~deletions~~)

2021 ~~2013~~ GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI

[…]

ANNEX 1[1]

GUIDANCE ON CALCULATION AND VERIFICATION OF EFFECTS OF CATEGORY (B) INNOVATIVE TECHNOLOGIES

[…]

~~Appendix 2~~

2 WIND PROPULSION SYSTEM (CATEGORY B-2)

[…]

2.3 Available effective power of wind propulsion systems

2.3.1 The available effective power of wind propulsion systems as innovative energy efficient technology is calculated by the following formula:

$$(f_{eff} \cdot P_{eff}) = \left(\frac{1}{\sum_{k=1}^{q} W_k}\right) \cdot \left(\left(\frac{0.5144 \cdot V_{ref}}{\eta_D} \sum_{k=1}^{q} F(V_{ref})_k \cdot W_k\right) - \left(\sum_{k=1}^{q} P(V_{ref})_k \cdot W_k\right)\right)$$

with $F_1 - F_k \geq 0 \wedge F_{k-1} - F_k \geq 0$

and $\sum_{k=1}^{q-1} W_k < \left[\frac{1}{3}\right]\left[\frac{1}{2}\right] \wedge \sum_{k=1}^{q} W_k \geq \left[\frac{1}{3}\right]\left[\frac{1}{2}\right]$

$$\cancel{(f_{eff} \cdot P_{eff}) = \left(\frac{0.5144 \cdot V_{ref}}{\eta_T} \sum_{i=1}^{m}\sum_{j=1}^{n} F(V_{ref})_{i,j} \cdot W_{i,j}\right) - \left(\sum_{i=1}^{m}\sum_{j=1}^{n} P(V_{ref})_{i,j} \cdot W_{i,j}\right)}$$

Where:

.1 (f_{eff} * P_{eff}) is the available effective power in kW delivered by the specified wind propulsion system. f_{eff} and P_{eff} are combined in the calculation because the product of availability and power is a result of a matrix operation, addressing each wind condition with a probability and a specific wind propulsion system force.

.2 The factor 0.5144 is the conversion factor from nautical miles per hour (knots) to metres per second (m/s).

[1] All examples in this chapter ~~appendix~~ are used solely to illustrate the proposed methods of calculation and verification.

.3 V_{ref} is the ship reference speed measured in nautical miles per hour (knots), as defined in the EEDI calculation guidelines.

.4 η_D ~~T~~ is the total efficiency of the main drive(s) at 75 per cent of the rated installed power (MCR) of the main engine(s). η_D shall be set to [0.7], if no other value is specified and verified by the verifier.

.5 $F(V_{ref})_k$ is the force matrix of the respective wind propulsion system for a given ship speed V_{ref}. Each matrix element represents the propulsion force in kilo newton (kN) for the respective wind speed and angle. The wind angle is given in relative bearings (with 0° on the bow).

.6 W_k is the global wind probability matrix ~~(see below)~~. Each matrix element represents the probability of wind speed and wind angle relative to the ship coordinates. The sum over all matrix elements equals 1 and is non-dimensional.

.7 $P(V_{ref})_k$ is a matrix with the same dimensions as $F(V_{ref})_k$ and W_k and represents the power demand in kW for the operation of the wind propulsion system.

2.3.2 The first term of the formula defines the additional propulsion power to be considered for the overall EEDI calculation. The term contains the product of the ship specific speed, the force matrix and the global wind probability matrix. The second term contains the power requirement for the operation of the specific wind propulsion system which has to be subtracted from the gained wind power.

[…]