AIR POLLUTION AND ENERGY EFFICIENCY

Progress report of SHOPERA and Japan's projects and outline of draft revised Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions

Submitted by Denmark, Germany and Japan

SUMMARY

Executive summary: This document provides information on the progress of SHOPERA and Japan's projects and the outline of draft revised Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions.

Strategic direction: 7.3

High-level action: 7.3.2

Output: 7.3.2.1

Action to be taken: Paragraph 15

Related documents: MEPC 70/INF.30; MEPC 70/INF.35; MSC 93/21/5, MSC 93/INF.13; MEPC 69/INF.23; MEPC 68/3/7, MEPC 68/3/11; MEPC 68/INF.32; MEPC 67/4/16, MEPC 67/4/25; MEPC 67/INF.14, MEPC 67/INF.22, MEPC 67/WP.12, MEPC 67/20; MEPC 64/4/42, MEPC 64/23; resolutions MEPC.232(65), MEPC.255(67) and MEPC.262(68)

Introduction

1. The 2012 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships (resolution MEPC.212(63)) represent a major step forward in implementing the regulations on energy efficiency of ships (resolution MEPC.203(62)). However, concerns had been expressed regarding sufficiency of propulsion and steering abilities of ships to maintain their manoeuvrability in adverse conditions if the EEDI requirements are achieved by simple reduction of the installed engine power. This gave a reason for additional considerations and studies by IACS, which served as a basis for the

https://edocs.imo.org/Final Documents/English/MEPC 70-5-20 (E).docx
Interim Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ship in adverse conditions (MSC-MEPC.2/Circ.11 (2012)), which was updated in annex 1 to document MEPC 65/4/3 and subsequently adopted by resolution MEPC.232(65) and was further updated by resolutions MEPC.255(67) and MEPC.262(68).

2 To address the challenges of this issue by more in depth research, the research project Energy Efficient Safe Ship Operation (SHOPERA, www.shopera.org) and Japan's research project (hereinafter referred as "the projects") have been working together for revising the Interim Guidelines through technical and practical considerations and evaluation with a view to submitting the outcome and draft revised Guidelines to MEPC 71 (spring of 2017). In the following the progress of the projects is summarised.

Ship types and ship sizes

3 The projects propose that the draft revised Guidelines should be applied, at this stage, only to tankers, bulk carriers and combination carriers. This proposal is based on case studies performed by both projects, which show that these ship types are most critical with respect to sufficient power for manoeuvrability in adverse conditions. The projects are of the opinion that further consideration should be made for other ship types at a later stage.

4 The projects have reached a conclusion that the application of the draft revised Guidelines should be limited to ships of 20,000 tonnes deadweight and above at this time because a systematic evaluation of the required standard environmental conditions has not been completed yet for ships with deadweight less than 20,000 tonnes. The projects are of the view that further consideration for these ships would be done in the future.

Loading condition

5 The projects have reached a conclusion that only maximum summer load condition corresponding to the EEDI condition should be evaluated for tankers, bulk carriers and combination carriers because it is most critical for the required propulsion power in adverse weather conditions over all loading conditions. The projects are of the view that required propulsion power under heavy ballast conditions is typically less than the required power under full load conditions based on the results of direct calculation methods. The projects are also of the view that normal ballast condition does not need to be considered because shipmasters normally change from the normal ballast condition to the heavy ballast condition according to the weather forecast in advance.

Scenarios of adverse conditions and manoeuvrability criteria

6 The projects have developed two scenarios of adverse conditions and manoeuvrability criteria based on interviews with ship's masters and chief engineers concerning ship's characteristics under adverse sea conditions.

7 The first scenario, "Avoidance of adverse seas - gale warning" considers a situation when ships avoid adverse seas in advance to prevent grounding, contact or collision, as well as damage to hull and cargo, while remaining fully functional regarding their manoeuvrability. The requirements for this scenario are as follows:

<table>
<thead>
<tr>
<th>Weather conditions</th>
<th>h₁/₃=3 m (BF6, strong breeze) for Lₚₚ&lt;200 m to h₁/₃=4 m (BF7, near gale) for Lₚₚ&gt;250 m, linear over Lₚₚ between 200 and 250 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encountered wave and wind angle</td>
<td>All headings, including beam seas and following seas</td>
</tr>
<tr>
<td>Propulsion ability</td>
<td>Speed through water at least 6 knots</td>
</tr>
<tr>
<td>Steering ability</td>
<td>Ability to perform any manoeuvre in seaway from any heading</td>
</tr>
</tbody>
</table>

https://edocs.imo.org/Final Documents/English/MEPC 70-5-20 (E).docx
8 The second scenario, "Escape from coastal area" considers situations when ships encounter adverse weather in the coastal area for some reason and should be able to escape from the coastal area in the worst case of onshore wind against weather (head to bow seas) to avoid grounding, contact or collision, with a speed through water of at least six knots. The requirements for this scenario are as follows:

<table>
<thead>
<tr>
<th>Weather conditions</th>
<th>$h^{1/3}=4\ m\ (BF7,\ near\ gale)$ for $L_{pp}&lt;200\ m$ to $h^{1/3}=5.5\ m\ (BF8,\ gale)$ for $L_{pp}&gt;250\ m$ linear over $L_{pp}$ between 200 and 250 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encountered wave and wind angle</td>
<td>Head seas to 60° off-bow</td>
</tr>
<tr>
<td>Propulsion ability</td>
<td>Speed through water at least 6 knots</td>
</tr>
</tbody>
</table>

9 Based on the assessment results, the second scenario "Escape from coastal area" is more demanding with respect to the required propulsion power for tankers, bulk carriers and combination carriers. Therefore, this scenario is proposed to evaluate the sufficiency of the ship's propulsion power to maintain the manoeuvrability in adverse weather conditions for bulk carriers, tankers and combination carriers.

### Weather conditions

10 Regarding the weather conditions which should be used in the assessment, the projects have considered the following:

1. under severe condition such as BF9 or more, ships experience seakeeping problems, such as propeller racing or deck wetness even if these ships have enough power for propulsion and steering; and

2. it is a common understanding of ships' masters and engineers that they should avoid meeting severe weather conditions like BF9 or more because encountering such an adverse weather condition could cause damage to ship structure, cargo and machinery.

11 The projects are of the view that the adverse weather conditions applied in the assessment should be calibrated based on the assessment results for existing ships. The assessment of many existing bulk carriers and tankers led to the conclusion that the weather condition written in resolution MEPC.232(65) and updated by resolutions MEPC.255(67) and MEPC.262(68) is suitable condition for this evaluation.

### Assessment procedures

12 The projects are of the view that designers and Administrations should be given a flexibility of applying assessment procedures of different complexity, ranging from simple, albeit conservative, empirical formulae, to more advanced procedures, depending on the needs of particular design, such as propulsion and steering characteristics of the ship under assessment. Therefore, the projects propose three different assessment procedures. A ship fulfilling the requirements of any of these procedures is evaluated as having sufficient propulsion power to maintain the manoeuvrability in adverse conditions. The procedures differ in their level of complexity and accuracy: in the order of increasing complexity and accuracy from 12.1 to 12.3, the proposed procedures are:

1. Minimum Power Lines: the projects propose that minimum power lines according to the resolution MEPC.232(65), as amended by resolutions MEPC.255(67) and MEPC.262(68), should still be applicable for tankers, bulkers and combination carriers, until sufficient verification results are available;
.2 [Minimum Power Check]: the projects have developed an empirical evaluation formula for the minimum propulsion power for tankers, bulk carriers and combination carriers, based on the scenarios and criteria shown above. For other ship types, further consideration should be made; and

.3 [Minimum Power Assessment]: the projects have developed an assessment procedure for the sufficiency of the propulsion power for tankers, bulk carriers and combination carriers, based on the evaluation of external forces and solution of surge equilibrium equation in accordance with the second scenario "Escape from coastal area".

13 For other ship types, the projects are of the view that further consideration for scenarios and criteria is necessary to propose suitable assessment procedures.

Outline of draft revised Guidelines

14 The annex to this document contains an outline of the draft revised Guidelines based on the progress and the outcome of the projects. The projects are of the view that they will further consider the draft revised Guidelines and submit a joint proposal, including the full text of the draft revised Guidelines, to MEPC 71. In this regard, any comments from Member States, IGOs and NGOs on the outline of the draft revised Guidelines are welcomed. Contact points are Dr. Vladimir Shigunov, SHOPERA (vladimir.shigunov@dnvgl.com) and Mr. Yasufumi Onishi, Japan (onishi@jstra.jp).

Action requested of the Committee

15 The Committee is invited to note the progress made and to consider the outline of the draft revised Guidelines, as set out in the annex, and take action as appropriate.

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ANNEX

OUTLINE OF THE DRAFT REVISED GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS

1 Purpose

1.1 The purpose of these draft revised Guidelines is to assist Administrations and Recognized Organizations (ROs) in verifying that ships, complying with EEDI requirements set out in regulations on Energy Efficiency for Ships, have sufficient propulsion and steering abilities to maintain the manoeuvrability in adverse conditions, as specified in regulation 21.5 in chapter 4 of MARPOL Annex VI.

2 Applicability

2.1 These Guidelines should be applied in the case of all new tankers, bulk carriers and combination carriers with the size of equal to or more than 20,000 DWT.

2.2 These Guidelines are intended for ships in unrestricted navigation. For other cases, the Administration should determine appropriate guidelines, taking the operational area and relevant restrictions into account.

3 Conditions of loading

3.1 These Guidelines should be applied in maximum summer load condition.

4 Acceptance criteria and environmental conditions

4.1 The ship should be considered to have sufficient propulsion and steering ability for manoeuvrability in adverse conditions if it satisfies the requirements of sufficient propulsion ability in seaway according to the assessment procedures defined in paragraph 5.

4.2 The significant wave height applied in the assessment is defined as $h_{1/3}=4$ m for $L_{pp}<200$ m to $h_{1/3}=5.5$ m for $L_{pp}>250$ m, linear over $L_{pp}$ between 200 and 250 m.

4.3 The assessment is performed in irregular waves described by the JONSWAP spectrum with the peak parameter 3.3 and $\cos^2$-directional spreading (alternatively, long-crested seaway can be assumed). The range of wave peak periods applied is from $3.6 \cdot h_{1/3}^{0.5}$ to $5.0 \cdot h_{1/3}^{0.5}$, seconds, with the step not exceeding [1.0] second. The corresponding wind speed, m/s, is defined as $3.2 \cdot h_{1/3}$.

5 Assessment procedures

5.1 Compliance with the requirements 4.1 to 4.3 can be demonstrated using any of the following three assessment procedures:

.1 Minimum Power Lines, according to the resolution MEPC.232(65), as amended by resolutions MEPC.255(67) and MEPC.262(68);

.2 [Minimum Power Check], according to paragraph 6; or

.3 [Minimum Power Assessment], according to paragraph 7.
6  [Minimum Power Check]

6.1  According to the [Minimum Power Check], the maximum continuous rating MCR of the main engine should not be less than the value calculated by using an empirical formula with the ship’s principal particulars.

7  [Minimum Power Assessment]

7.1  [Minimum Power Assessment] is based on the solution of surge equilibrium equation to demonstrate that the ship is able to move with the speed of 6 knots through water in wave directions from head to 60° off-bow. The Assessment consists of the following steps:

  .1  calculate the maximum total resistance in the direction of surge over wave directions from head to 60° off-bow;
  
  .2  calculate corresponding required brake power and rotation speed of the engine, taking into account the actual propulsion characteristics of the ship; and
  
  .3  check whether the required brake power does not exceed the brake power limit, defined according to the engine manufacturer data at the actual rotation speed of the engine.

7.2  The following evaluation methods can be used to define the maximum total resistance in the direction of surge over wave directions from head to 60° off-bow and other relevant characteristics:

  .1  calm water resistance, propeller open-water characteristics and self-propulsion factors are defined by the methods approved for the EEDI verification;
  
  .2  wind resistance: from wind tunnel test, empirical formulae or an equivalent method verified by the Administration or ROs; and
  
  .3  added resistance in waves: from tank model test, empirical formula or an equivalent method verified by the Administration or ROs.

7.3  The details of the [Minimum Power Assessment] procedure are provided in the supplementary information on minimum power assessment procedure, set out in document MEPC 70/INF.30.