標題

荒天下における操船性を維持するための最低推進出力要件について(EEDI 関連規定)

ClassNK
テクニカル
インフォメーション

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各位

エネルギー効率設計指標(EEDI: Energy Efficiency Design Index)の規制値への適合が要求される船舶に対して適用される最低推進出力要件については、ClassNK テクニカル・インフォメーション No.TEC-1017 にてお知らせしておりますが、今般、当該要件を定めるためのガイドラインが改正されましたので、以下の通りお知らせいたします。

これにより、2014 年 12 月 26 日付発行の ClassNK テクニカル・インフォメーション No.TEC-1017 を絶版といたします。

1. 背景

MARPOL 条約附属書 VI の第 21 規則により EEDI 規制値への適合が要求される船舶にあっては、同 21.5 規則により、荒天下における操船性を維持するため、IMO が策定するガイドラインに従って一定以上の推進出力を有することが要求されます。

2013 年 5 月に開催された IMO 第 65 回海洋環境保護委員会(MEPC 65)において、船舶が備えるべき最低推進出力を決定するための暫定ガイドライン(以下、最低推進出力暫定ガイドライン)が採択されました。また、2014 年 10 月に開催された MEPC 67 における審議の結果、適用対象船舶及び評価手法(Level 1/Level 2)を維持したまま、最低推進出力暫定ガイドラインをフェーズ 1 の期間(2015 年 1 月から 2019 年 12 月)まで、延長適用することが合意されました。

一方、MEPC 67 において、安全性に対する懸念から最低推進出力暫定ガイドラインの要件強化を強く主張する一部意見があり、MEPC 68 以降に引き続き審議されることになりました。

2. 最低推進出力暫定ガイドラインの一部改正

2015 年 5 月に開催された MEPC 68 の審議の結果、Level 1 評価の要件を改正することが合意され、最低推進出力暫定ガイドラインの一部改正が採択されました。Level 2 評価については、現在欧州や日本で実施されている学術的な調査研究の成果が得られるまでは改正せず、現行の要件を維持することが合意されました。

なお、改正ガイドラインの適用期日については、採択後 6 か月の導入期間を設けることが合意され、2015 年 11 月 16 日以降に建造契約が結ばれる船舶に適用されることとなりました。

(次頁に続く)

3. 最低推進出力の評価手法

本要件の適用対象船舶につきましては、最低推進出力暫定ガイドラインに従い、以下の二段階評価のうち、どちらかの評価レベルを満足することが要求されます（第一段階の評価レベルを満足しない場合は、第二段階の評価レベルを満足することが要求されます）。

(1) 最低推進出力ラインによる評価（第一段階：Level 1 評価）

第一段階の評価として、最低推進出力ラインが船種毎に下表に示す数式（載荷重量 DWT の関数）により設定されており、推進出力（搭載主機出力の合計）が最低推進出力ラインの値以上であることが要求されます。

船 種	最低推進出力 (kW)
ばら積貨物船 (20,000 ≤ DWT)	0.0687 x DWT + 2924.4
タンカー及び兼用船 (20,000 ≤ DWT)	0.0689 x DWT + 3253.0

2015 年 11 月 16 日以降に建造契約が結ばれる船舶の Level 1 最低推進出力ライン

船 種	最低推進出力 (kW)
ばら積貨物船 (20,000 ≤ DWT < 145,000)	0.0763 x DWT + 3374.3
ばら積貨物船 (145,000 ≤ DWT)	0.0490 x DWT + 7329.0
タンカー及び兼用船 (20,000 ≤ DWT)	0.0652 x DWT + 5960.2

(2) 簡易評価（第二段階：Level 2 評価）

第二段階は間接的な簡易評価手法であり、荒天海象(adverse condition)において、正面からの向波、向風の条件下で船舶が一定の前進速力で航海できる推進出力を有しており、かつ、その状態が搭載主機のトルクリミット以下（作動範囲内）であれば、全方位からの波や風の条件下でも船舶が針路を保つことができるとの仮定に基づいています。

最低推進出力暫定ガイドラインでは、第二段階評価で考慮する荒天海象(adverse condition)を下表のとおり定義しています。

船の長さ L_{pp} (m)	有義波高(m)	ピーク波周期(s)	平均風速(m/s)
200m 未満	4.0	7.0 to 15.0	15.7
200m 以上 250m 未満	*		*
250m 以上	5.5		19.0

（*船の長さに応じた線形補間値）

簡易評価は、以下の 3 ステップで構成されます。

(i) ステップ 1: 全方位からの波や風の条件下でも保針が担保可能な、正面からの向波、向風における要求前進速力(VS)を決定します。
(ii) ステップ 2: 要求前進速力(VS)に必要な推進出力(Preq)を求め、搭載出力の合計が推進出力(Preq)以上であることを確認します。
(iii) ステップ 3: 推進出力（Preq）におけるトルクが、搭載主機のトルクリミット以下（作動範囲内）であることを確認します。

評価手順の詳細に関しましては、添付 2.の Appendix をご参照ください。

（次頁に続く）

4. 最低推進出力要件への適合確認
最低推進出力要件への適合確認は、設計段階における EEDI 予備認証において実施いたします。第二段階の簡易評価を適用した場合には、追加資料として以下の書類をご提出ください。なお、第一段階の最低推進出力ラインを満足する船舶の場合、資料提出は不要です。
- 第二段階評価の計算書
- 舵面積が確認できる資料
- 風圧面積（正面投影面積、側面投影面積）が確認できる資料
- 風圧抵抗の算出根拠（簡易推定式を使用しない場合）
- 平水中抵抗や自航要素の算出根拠（簡易推定式を使用しない場合）
- 波浪中抵抗増加の算出根拠（水槽試験結果又は計算結果）
- デザインプロペラの単独特性
- 搭載主機に関する資料（トルクリミットに関する情報を含む）
- その他弊会が必要と認める資料

なお、本件に関してご不明な点は、以下の部署にお問い合わせください。

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添付:

1. Resolution MEPC.262(68)
Amendments to the 2013 interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions (Resolution MEPC.232(65), as amended by Resolution MEPC.255(67))

2. MEPC.1/Circ.850/Rev.1
2013 interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions, as amended (Resolution MEPC.232(65), as amended by Resolution MEPC.255(67) and MEPC.262(68))

ANNEX 7

RESOLUTION MEPC.262(68)
(adopted on 15 May 2015)

AMENDMENTS TO THE 2013 INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS (RESOLUTION MEPC.232(65), AS AMENDED BY RESOLUTION MEPC.255(67))

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that, at its sixty-second session, it adopted, by resolution MEPC.203(62), Amendments to the annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (inclusion of regulations on energy efficiency for ships in MARPOL Annex VI),

NOTING that the aforementioned amendments to MARPOL Annex VI entered into force on 1 January 2013,

NOTING ALSO that regulation 21.5 of MARPOL Annex VI, as amended, requires that the installed propulsion power shall not be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions as defined in guidelines to be developed by the Organization,

NOTING FURTHER that, at its sixty-fifth session, it adopted, by resolution MEPC.232(65), the *2013 Interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions* (the interim guidelines) and, at its sixty-seventh session, by resolution MEPC.255(67), amendments thereto,

RECOGNIZING that the amendments to MARPOL Annex VI require the adoption of relevant guidelines for the smooth and uniform implementation of the regulations and to provide sufficient lead time for industry to prepare,

HAVING CONSIDERED, at its sixty-eighth session, proposed amendments to the interim guidelines,

1 ADOPTS amendments to the *2013 Interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions*, as amended, as set out in the annex to the present resolution;

2 INVITES Administrations to take the aforementioned amendments into account when developing and enacting national laws which give force to and implement provisions set forth in regulation 21.5 of MARPOL Annex VI, as amended;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the amendments to the attention of shipowners, ship operators, shipbuilders, ship designers and any other interested groups;

4 AGREES to keep the interim guidelines, as amended, under review, in light of experience gained with their application.

ANNEX

AMENDMENTS TO THE 2013 INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS (RESOLUTION MEPC.232(65), AS AMENDED BY RESOLUTION MEPC.255(67))

Appendix – Assessment procedures to maintain the manoeuvrability under adverse conditions, applicable during phase 0 and phase 1 of the EEDI implementation

Table 1 in paragraph 2 is replaced as follows:

"

Table 1: Parameters a and b for determination of the minimum power line values for the different ship types

Ship type	**a**	**b**
Bulk carrier which DWT is less than 145,000	0.0763	3374.3
Bulk carrier which DWT is 145,000 and over	0.0490	7329.0
Tanker	0.0652	5960.2
Combination Carrier	see tanker above	

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MEPC.1/Circ.850/Rev.1
15 July 2015

2013 INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS, AS AMENDED (RESOLUTION MEPC.232(65), AS AMENDED BY RESOLUTIONS MEPC.255(67) AND MEPC.262(68))

1 The Marine Environment Protection Committee, at its sixty-eighth session (11 to 15 May 2015), adopted, by resolution MEPC.262(68), amendments to the *2013 Interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions* (resolution MEPC.232(65), as amended by MEPC.255(67)) (MEPC 68/21, paragraph 3.101).

2 The Committee agreed to a phase-in period of six months for the application of the amendments (MEPC 68/21, paragraph 3.101).

3 A consolidated text of the guidelines, as requested by the Committee (MEPC 68/21, paragraph 3.101), is set out in the annex.

4 Member Governments are invited to bring the annexed *2013 Interim guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions*, as amended, to the attention of Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

2013 INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS, AS AMENDED (RESOLUTION MEPC.232(65), AS AMENDED BY RESOLUTIONS MEPC.255(67) AND MEPC.262(68))

0 Purpose

The purpose of these interim guidelines is to assist Administrations and recognized organizations in verifying that ships complying with EEDI requirements set out in regulations on energy efficiency for ships have sufficient installed propulsion power to maintain the manoeuvrability in adverse conditions, as specified in regulation 21.5 of chapter 4 of MARPOL Annex VI.

1 Definition

1.1 "Adverse conditions" mean sea conditions with the following parameters:

Significant wave height h_s, m	Peak wave period T_P, s	Mean wind speed V_w, m/s
5.5	7.0 to 15.0	19.0

JONSWAP sea spectrum with the peak parameter of 3.3 is to be considered for coastal waters.

1.2 The following adverse condition should be applied to ships defined by the following threshold values of ship size.

Ship length, m	Significant wave height h_s, m	Peak wave period T_P, s	Mean wind speed V_w, m/s
Less than 200	4.0	7.0 to 15.0	15.7
$200 \leq L_{pp} \leq 250$	Parameters linearly interpolated depending on ship's length		
More than $L_{pp} = 250$	Refer to paragraph 1.1		

2 Applicability*

2.1 These guidelines should be applied in the case of all new ships of types as listed in table 1 of the appendix required to comply with regulations on energy efficiency for ships according to regulation 21 of MARPOL Annex VI.

2.2 Notwithstanding the above, these guidelines should not be applied to ships with non-conventional propulsion systems, such as pod propulsion.

2.3 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.

* These interim guidelines are applied to ships required to comply with regulations on energy efficiency for ships according to regulation 21 of MARPOL Annex VI during phase 0 and phase 1 (i.e. for those ship types as in table 1 of appendix with a size of equal or more than 20,000 DWT).

3 Assessment procedure

3.1 The assessment can be carried out at two different levels as listed below:

.1 minimum power lines assessment; and

.2 simplified assessment.

3.2 The ship should be considered to have sufficient power to maintain the manoeuvrability in adverse conditions if it fulfils one of these assessment levels.

4 Assessment level 1 – minimum power lines assessment

4.1 If the ship under consideration has installed power not less than the power defined by the minimum power line for the specific ship type, the ship should be considered to have sufficient power to maintain manoeuvrability in adverse conditions.

4.2 The minimum power lines for the different types of ships are provided in the appendix.

5 Assessment level 2 – simplified assessment

5.1 The methodology for the simplified assessment is provided in the appendix.

5.2 If the ship under consideration fulfils the requirements as defined in the simplified assessment, the ship should be considered to have sufficient power to maintain manoeuvrability in adverse conditions.

6 Documentation

Test documentation should include at least, but not be limited to, a:

.1 description of the ship's main particulars;

.2 description of the ship's relevant manoeuvring and propulsion systems;

.3 description of the assessment level used and results; and

.4 description of the test method(s) used with references, if applicable.

APPENDIX

ASSESSMENT PROCEDURES TO MAINTAIN THE MANOEUVRABILITY UNDER ADVERSE CONDITIONS, APPLICABLE DURING PHASE 0 AND PHASE 1 OF THE EEDI IMPLEMENTATION

1 Scope

1.1 The procedures as described below are applicable during phase 0 and phase 1 of the EEDI implementation as defined in regulation 21 of MARPOL Annex VI (see also paragraph 0 – Purpose of these interim guidelines).

2 Minimum power lines

2.1 The minimum power line values of total installed MCR, in kW, for different types of ships should be calculated as follows:

Minimum Power Line Value = $a \times (DWT) + b$

where:

DWT is the deadweight of the ship in metric tons; and
a and *b* are the parameters given in table 1 for tankers, bulk carriers and combination carriers.

Table 1: Parameters a and b for determination of the minimum power line values for the different ship types

Ship type	a	b
Bulk carrier which DWT is less than 145,000	0.0763	3374.3
Bulk carrier which DWT is 145,000 and over	0.0490	7329.0
Tanker	0.0652	5960.2
Combination carrier	see tanker above	

2.2 The total installed MCR of all main propulsion engines should not be less than the minimum power line value, where MCR is the value specified on the EIAPP Certificate.

3 Simplified assessment

3.1 The simplified assessment procedure is based on the principle that, if the ship has sufficient installed power to move with a certain advance speed in head waves and wind, the ship will also be able to keep course in waves and wind from any other direction. The minimum ship speed of advance in head waves and wind is thus selected depending on ship design, in such a way that the fulfilment of the ship speed of advance requirements means fulfilment of course-keeping requirements. For example, ships with larger rudder areas will be able to keep course even if the engine is less powerful; similarly, ships with a larger lateral windage area will require more power to keep course than ships with a smaller windage area.

3.2 The simplification in this procedure is that only the equation of steady motion in longitudinal direction is considered; the requirements of course-keeping in wind and waves are taken into account indirectly by adjusting the required ship speed of advance in head wind and waves.

3.3 The assessment procedure consists of two steps:

.1 definition of the required advance speed in head wind and waves, ensuring course-keeping in all wave and wind directions; and

.2 assessment whether the installed power is sufficient to achieve the required advance speed in head wind and waves.

Definition of required ship speed of advance

3.4 The required ship advance speed through the water in head wind and waves, V_s, is set to the larger of:

.1 minimum navigational speed, V_{nav}; or

.2 minimum course-keeping speed, V_{ck}.

3.5 The minimum navigational speed, V_{nav}, facilitates leaving coastal area within a sufficient time before the storm escalates, to reduce navigational risk and risk of excessive motions in waves due to unfavourable heading with respect to wind and waves. The minimum navigational speed is set to 4.0 knots.

3.6 The minimum course-keeping speed in the simplified assessment, $V_{ck,}$ is selected to facilitate course-keeping of the ships in waves and wind from all directions. This speed is defined on the basis of the reference course-keeping speed $V_{ck,\ ref}$, related to ships with the rudder area A_R equal to 0.9% of the submerged lateral area corrected for breadth effect, and an adjustment factor taking into account the actual rudder area:

$$V_{ck} = V_{ck,\ ref} - 10.0 \times (A_{R\%} - 0.9) \quad (1)$$

where V_{ck} in knots, is the minimum course-keeping speed, $V_{ck,\ ref}$ in knots, is the reference course-keeping speed, and $A_{R\%}$ is the actual rudder area, A_R, as percentage of the submerged lateral area of the ship corrected for breadth effect, $A_{LS,\ cor}$, calculated as $A_{R\%} = A_R/A_{LS,\ cor} \cdot 100\%$. The submerged lateral area corrected for breadth effect is calculated as $A_{LS,\ cor} = L_{pp}T_m(1.0+25.0(B_{wl}/L_{pp})^2)$, where L_{pp} is the length between perpendiculars in m, B_{wl} is the water line breadth in m and T_m is the draft a midship in m. In case of high-lift rudders or other alternative steering devices, the equivalent rudder area to the conventional rudder area is to be used.

3.7 The reference course-keeping speed $V_{ck,\ ref}$ for bulk carriers, tankers and combination carriers is defined, depending on the ratio A_{FW}/A_{LW} of the frontal windage area, A_{FW}, to the lateral windage area, A_{LW}, as follows:

.1 9.0 knots for $A_{FW}/A_{LW} = 0.1$ and below and 4.0 knots for $A_{FW}/A_{LW} = 0.40$ and above; and

.2 linearly interpolated between 0.1 and 0.4 for intermediate values of A_{FW}/A_{LW}.

Procedure of assessment of installed power

3.8 The assessment is to be performed in maximum draught conditions at the required ship speed of advance, V_s, defined above. The principle of the assessment is that the required propeller thrust, T in N, defined from the sum of bare hull resistance in calm water R_{cw}, resistance due to appendages R_{app}, aerodynamic resistance R_{air}, and added resistance in

waves R_{aw}, can be provided by the ship's propulsion system, taking into account the thrust deduction factor t:

$$T = (R_{cw} + R_{air} + R_{aw} + R_{app})/(1-t) \quad (2)$$

3.9 The calm-water resistance for bulk carriers, tankers and combination carriers can be calculated neglecting the wave-making resistance as $R_{cw} = (1+k)C_F \frac{1}{2}\rho S V_s^2$, where k is the form factor, $C_F = \frac{0.075}{(\log_{10}\mathrm{Re}-2)^2}$ is the frictional resistance coefficient, $\mathrm{Re} = V_s L_{pp}/\nu$ is the Reynolds number, ρ is water density in kg/m^3, S is the wetted area of the bare hull in m^2, V_s is the ship advance speed in m/s, and ν is the kinematic viscosity of water in m^2/s.

3.10 The form factor k should be obtained from model tests. Where model tests are not available the empirical formula below may be used:

$$k = -0.095 + 25.6\frac{C_B}{(L_{pp}/B_{wl})^2\sqrt{B_{wl}/T_m}} \quad (3)$$

where C_B is the block coefficient based on L_{pp}.

3.11 Aerodynamic resistance can be calculated as $R_{air} = C_{air}\frac{1}{2}\rho_a A_F V_{w,rel}^2$, where C_{air} is the aerodynamic resistance coefficient, ρ_a is the density of air in kg/m^3, A_F is the frontal windage area of the hull and superstructure in m^2, and $V_{w\,rel}$ is the relative wind speed in m/s, defined by the adverse conditions in paragraph 1.1 of the interim guidelines, V_w, added to the ship advance speed, V_s. The coefficient C_{air} can be obtained from model tests or empirical data. If none of the above is available, the value 1.0 is to be assumed.

3.12 The added resistance in waves, R_{aw}, defined by the adverse conditions and wave spectrum in paragraph 1 of the interim guidelines, is calculated as:

$$R_{aw} = 2\int_0^\infty \frac{R_{aw}(V_s,\omega)}{\zeta_a^2} S_{\zeta\zeta}(\omega)\,d\omega \quad (4)$$

where $R_{aw}(V_s,\omega)/\zeta_a^2$ is the quadratic transfer function of the added resistance, depending on the advance speed V_s in m/s, wave frequency ω *in rad/s*, the wave amplitude, ζ_a *in m* and the wave spectrum, $S_{\zeta\zeta}$ *in m^{2}s*. The quadratic transfer function of the added resistance can be obtained from the added resistance test in regular waves at the required ship advance speed V_s as per ITTC procedures 7.5-02 07-02.1 and 7.5-02 07-02.2, or from equivalent method verified by the Administration.

3.13 The thrust deduction factor t can be obtained either from model tests or empirical formula. Default conservative estimate is $t = 0.7w$, where w is the wake fraction. Wake fraction w can be obtained from model tests or empirical formula; default conservative estimates are given in table 2.

Table 2: Recommended values for wake fraction *w*

Block coefficient	One propeller	Two propellers
0.5	0.14	0.15
0.6	0.23	0.17
0.7	0.29	0.19
0.8 and above	0.35	0.23

3.14 The required advance coefficient of the propeller is found from the equation:

$$T = \rho u_a^2 D_P^2 K_T(J)/J^2 \quad (5)$$

where D_P is the propeller diameter, $K_T(J)$ is the open water propeller thrust coefficient, $J = u_a/nD_P$, and $u_a = V_s(1-w)$. J can be found from the curve of K_T (J)/J^2.

3.15 The required rotation rate of the propeller, *n*, in revolutions per second, is found from the relation:

$$n = u_a/(JD_P) \quad (6)$$

3.16 The required delivered power to the propeller at this rotation rate *n*, P_D in watt, is then defined from the relation:

$$P_D = 2\pi\rho n^3 D_P^5 K_Q(J) \quad (7)$$

where $K_Q(J)$ is the open water propeller torque coefficient curve. Relative rotative efficiency is assumed to be close to 1.0.

3.17 For diesel engines, the available power is limited because of the torque-speed limitation of the engine, $Q \le Q_{max}(n)$, where $Q_{max}(n)$ is the maximum torque that the engine can deliver at the given propeller rotation rate *n*. Therefore, the required minimum installed MCR is calculated taking into account:

.1 torque-speed limitation curve of the engine which is specified by the engine manufacturer; and

.2 transmission efficiency η_s which is to be assumed 0.98 for aft engine and 0.97 for midship engine, unless exact measurements are available.

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