Subject

Minimum Propulsion Power required by the Amendments to ANNEX VI of MARPOL 73/78 (EEDI related Requirements)

ClassNK
Technical Information

No. TEC-0938
Date 18 December 2012

To whom it may concern

Amendments to MARPOL ANNEX VI that make the "Energy Efficiency Design Index (EEDI)" and the "Ship Efficiency Management Plan (SEEMP)" mandatory were adopted at the 62nd session of the Marine Environment Protection Committee (MEPC 62) held in July 2011, and will come into force from 1 January 2013.
Relevant information on the amendments to MARPOL ANNEX VI has already been provided in ClassNK Technical Information Nos. TEC-0863, TEC-0872 and TEC-0929. This ClassNK Technical Information provides additional information regarding a specific requirement on minimum propulsion power specified in the amendment to MARPOL ANNEX VI.

1. Background
   For ships to which the requirements regarding required EEDI specified in Reg.21 of MARPOL ANNEX VI apply, the installed propulsion power is not to be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions as defined in the guidelines developed by the IMO, in accordance with Reg.21.5 of ANNEX VI.
   After considerable deliberations at the 64th session of the Marine Environment Protection Committee (MEPC 64) held in October 2012 and the 91st session of the Maritime Safety Committee (MSC 91) subsequently held in November 2012, "Interim Guidelines for Determining Minimum Propulsion Power to Maintain the Manoeuvrability of Ships in Adverse Conditions" (hereinafter referred to as "interim minimum power guidelines") was developed and issued as MSC-MEPC.2/Circ.11.

2. Application
   The interim minimum power guidelines are applicable only to bulk carriers, tankers and combination carriers to which compliance with an EEDI limit value (required EEDI) is required by Reg.21 of MARPOL ANNEX VI*.

   * Applies to bulk carriers, tankers or combination carriers of 20,000DWT or above for which either the building contract is placed on or after 1 January 2013, or in the absence of a building contract, the keel of which is laid or which is at a similar stage of construction on or after 1 July 2013, or the delivery of which is on or after 1 July 2015.

(To be continued)

3. Required minimum propulsion power
   In principle, the installed propulsion power (total main engine outputs) of any ship of the type mentioned in paragraph 2 above is not to be less than the power calculated using the formula shown in the following table.

Ship Type	Minimum Propulsion Power (kW)
Bulk Carrier	0.0687 x DWT + 2924.4
Tanker/Combination Carrier	0.0689 x DWT + 3253.0

4. Future plans concerning minimum power guidelines
   At MEPC 64, it was agreed that the interim minimum power guidelines should be further examined and fine-tuned as necessary at MEPC 65, scheduled to be held in May 2013 or later.
   In the event that any revision is made in the interim minimum power guidelines, related information on the revision will be provided via another ClassNK Technical Information release.

For any questions about the above, please contact:

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1. Interim Guidelines for Determining Minimum Propulsion Power to Maintain the Manoeuvrability of Ships in Adverse Conditions (MSC-MEPC.2/Circ.11)

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MSC-MEPC.2/Circ.11
3 December 2012

INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS

1 The Marine Environment Protection Committee, at its sixty-fourth session, and the Maritime Safety Committee, at its ninety-first session, approved the Interim Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions, as set out in the annex to this circular, which provides a guide for Administrations and recognized organizations acting on their behalf, when they consider and decide a ship in question meets the requirement of regulation 21.5 of MARPOL Annex VI.

2 Member Governments and observer organizations are invited to use the interim guidelines on an interim basis until improved guidelines becomes available.

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ANNEX

INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS

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 in chapter 4 of MARPOL Annex VI.

These interim guidelines can be used until improved guidelines become available.

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
6.0	8.0 to 15.0	19.0

2 Applicability

2.1 These guidelines should be applied in the case of all new ships categorized 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 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 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 the manoeuvrability in adverse conditions.

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

4.3 If the minimum power lines assessment is not fulfilled, then the simplified assessment may be applied.

5 Assessment level 2 – simplified assessment

5.1 The simplified assessment is applicable only to ships whose rudder area is not less than 0.9 per cent of the submerged lateral area corrected for breadth effect.

5.2 The submerged lateral area corrected for breadth effect is calculated as $LppTm(1.0+25.0(Bwl/Lpp)^2)$.

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

5.4 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 the manoeuvrability in adverse conditions.

6 Documentation

6.1 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.

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Appendix

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

1 Scope

1.1 The procedures as described below are applicable during Phase 0 of the EEDI implementation as defined in chapter 4 of MARPOL Annex VI (see also paragraph 0 Purpose of this interim guidelines).

2 Minimum power lines

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

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

Where:

DWT is the deadweight of the ship in metric tons; and
a and *b* are the parameters given in Table 1.

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

Ship Type	a	b
Bulk Carriers	0.0687	2924.4
Tankers	0.0689	3253.0
Combination Carriers	see Tankers above	

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 advance speed in head waves and wind is thus selected depending on ship design in such a way, that the fulfilment of the advance speed 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 larger lateral windage area will require more power to keep course than ships with 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 advance speed 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 advance speed

3.4 The required advance speed in head wind and waves is set to the larger of:

.1 minimum navigational speed; or

.2 minimum course-keeping speed.

3.5 The minimum navigational speed facilitates leaving coastal area within a sufficient time 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 in waves and wind from all directions. This speed is defined on the basis of the reference course-keeping speed V_{ref}, related to ships with the rudder area A_R equal to 0.9 per cent of the submerged lateral area corrected for breadth effect, and a reduction factor taking into account the actual rudder area:

$$V_{ck} = V_{ref} - 10.0 \times (A_R\% - 0.9\%)$$

where V_{ck} is the required advance speed, knots, in head wind and waves to facilitate course-keeping in all wind and wave directions, V_{ref}, knots, is the reference advance speed, and A_R% is the actual rudder area as percentage of the submerged lateral area corrected for breadth effect.

3.7 The reference advance speed V_{ref} is defined, depending on the block coefficient C_B and the ratio A_F/A_L of the frontal windage area to the lateral windage area, as follows:

.1 for ships with the block coefficient $C_B \leq 0.74$: 16.0 and 9.0 knots for the ratio of the frontal windage area to lateral windage area, A_F/A_L=0.1 and 0.4, respectively;

.2 for ships with the block coefficient $C_B \geq 0.84$: 9.0 and 4.0 knots for the ratio of the frontal windage area to lateral windage area, A_F/A_L=0.1 and 0.40, respectively; and

.3 linearly interpolated for intermediate values of C_B and A_F/A_L.

The above is summarized in table 2.

Table 2: Definition of reference minimum required course-keeping speed at minimum rudder area in knots

C_B	A_F/A_L=0.1	A_F/A_L=0.4
less than or equal to 0.74	16.0	9.0
more than or equal to 0.84	9.0	4.0

Procedure of assessment of installed power

3.8 The assessment is to be performed in maximum draught condition at the required advance speed defined above. The principle of the assessment is that the required propeller thrust, T, 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:

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

3.9 The calm-water resistance can be calculated neglecting the wave 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, kg/m^3, S is the wetted area of the bare hull, m^2, V_s is the ship speed, m/s, and ν is the kinematic viscosity of water, m^2/s.

3.10 The form factor k can be obtained either from model tests or empirical formula below:

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

3.11 Aerodynamic resistance can be calculated as $R_{air} = C_{air}\frac{1}{2}\rho_a A_F V_w^2$, where C_{air} is the aerodynamic resistance coefficient, ρ_a is the density of air, kg/m^3, A_F is the frontal windage area of the hull, m^2, and V_w is the relative wind speed, m/s, defined by the adverse conditions in paragraph 1.1 of the interim guidelines plus the ship advance speed. 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, defined by the adverse conditions in paragraph 1.1 of the interim guidelines, R_{aw}, can be derived from model test. The model test should be added resistance test in regular waves at the required advance speed as per ITTC procedure 7.5-02 07-02.1.

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 defined below.

3.14 In order to check whether the required thrust can be provided by the engine, the required advance ratio of the propeller J is found from the equation:

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

where $K_T(J)$ is the thrust coefficient curve, and $u_a = V_s(1-w)$. Wake fraction w can be obtained from model tests or empirical formula; default conservative estimates are given in table 3.

Table 3: 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	0.35	0.23

3.15 The required rotation speed of the propeller is found from the relation:

$$n = u_a / (J D_P) \quad (3)$$

3.16 The required power is then defined from the relation

$$P_D = 2\pi\rho n^3 D_P^5 K_Q(J) \quad (4)$$

3.17 For diesel engines, the available power is limited because of the torque-speed limitation of the engine $Q \le Q_{max}(n)$. Therefore, an additional requirement shall be evaluated as:

$$Q = P_D / (2\pi n) \le Q_{max}(n). \quad (5)$$