

標題

IACS Procedural Requirement No.38 (PR38) の制定について(EEDI 関連)

# ClassNK

## テクニカル インフォメーション

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各位

2013 年 1 月 1 日に発効した改正 MARPOL 附属書 VI にて要求されるエネルギー効率設計指標 (EEDI) に関連し、EEDI の計算及び認証のための手順要件を定める IACS Procedural Requirement No. 38 (PR38) が以下の通り制定されましたのでお知らせ致します。

### 1. 背景

IACS と業界 (船主、造船所、研究機関等) による合同作業部会 (JWG/EEDI) により、IMO の EEDI 関連ガイドラインについて、実務的な面から補足的指針を与えるための「インダストリーガイドライン (第一版)」が策定されました。

2012 年 12 月に開催された第 66 回 IACS 理事会の結果、インダストリーガイドラインを IACS Procedural Requirement として採用することが決定し、2013 年 5 月に PR38 として採択されました。

これにより、インダストリーガイドラインは、IACS の全船級協会が従うべき手順として用いられることとなります。

### 2. 適用

本 PR38 は、2013 年 7 月 1 日以降に建造契約が行われる船舶 (EEDI 適用船) に対して適用されます。

上記 2. に該当する船舶の EEDI 計算及び認証の際には、関連の IMO ガイドラインに加えて、PR38 の手順要件に従うことが要求されますのでご注意ください。

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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### 1. IACS Procedural Requirement No.38 (PR38)

Procedure for calculation and verification of the Energy Efficiency Design Index (EEDI)

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# No. 38 Procedure for calculation and verification of the Energy Efficiency Design Index (EEDI)

(May 2013)

## Introduction

This procedure applies to all cases of Class Societies' involvement in conducting the survey and certification of EEDI in accordance with regulations 5, 6, 7, 8 and 9 of MARPOL Annex VI as a Verifier defined in the "2012 Guidelines on Survey and Certification of the Energy Efficiency Design Index (EEDI)" IMO Resolution MEPC 214(63).

## 1 Definition

"Industry Guidelines" means the Industry Guidelines for calculation and verification of the Energy Efficiency Design Index (EEDI) as first submitted to MEPC 64 that may be revised in order to remain in line with the relevant IMO Guidelines MEPC.212(63) and MEPC.214(63).

## 2 Scope of the Procedure

The scope of this procedure is defined in Part I of the Industry Guidelines and corresponds to the calculation and verification of EEDI of cargoships, without considering innovative energy efficient technologies, contracted for construction after 1 July 2013.

## 3 Calculation of EEDI

The procedure to compute the EEDI is documented in Part II of the Industry Guidelines. For the purpose of this Procedural Requirement, calculation of the EEDI is to be performed in accordance with IMO Guidelines MEPC.212(63) and Part II of the Industry Guidelines, as amended.

## 4 Verification of EEDI

The procedure to verify the EEDI is documented in Part III of the Industry Guidelines, together with Appendixes 1, 3, 4 and 5. For the purpose of this Procedural Requirement, verification of the EEDI is to be performed in accordance with IMO Guidelines MEPC.214(63) and Part III of the Industry Guidelines, as amended.

A sample of document to be submitted to the Verifier including additional information for verification is provided in Appendix 2 of the Industry Guidelines.

Attached:

First Industry Guidelines for calculation and verification of the Energy Efficiency Design Index (EEDI)

Note:

1. This Procedural Requirement applies from 1 July 2013.
2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contract for construction", refer to IACS Procedural Requirement (PR) No. 29.

End of Document

**FIRST INDUSTRY GUIDELINES FOR CALCULATION AND VERIFICATION OF THE ENERGY  
EFFICIENCY DESIGN INDEX (EEDI)**

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# Part I - Scope of the Industry Guidelines

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## 1 SCOPE OF THE GUIDELINES

### 1.1 Objective

The objective of these Industry Guidelines for calculation and verification of the Energy Efficiency Design Index (EEDI), hereafter designated as "the Industry Guidelines", is to provide details and examples of calculation of attained EEDI and to support the method and role of the verifier in charge of conducting the survey and certification of EEDI in compliance with the two following IMO Guidelines:

- 2012 Guidelines on the method of calculation of EEDI for new ships, Res. MEPC.212(63) adopted on 2 March 2012, referred to as the "IMO Calculation Guidelines" in the present document
- 2012 Guidelines on survey and certification of EEDI, Res. MEPC.214(63) adopted on 2 March 2012, referred to as the "IMO Verification Guidelines" in the present document

In the event that the IMO Guidelines are amended, then pending amendment of these Industry Guidelines, they are to be implemented in compliance with the amended IMO Guidelines.

### 1.2 Application

These Guidelines apply to new ships as defined in Regulation 2.23 of MARPOL Annex VI of 400 gross tonnage and above. The calculation and verification of EEDI are to be performed for each:

1. new ship before ship delivery
2. new ship in service which has undergone a major conversion
3. new or existing ship which has undergone a major conversion that is so extensive that the ship is regarded by the Administration as a newly constructed ship

The Industry Guidelines shall not apply to ships which have diesel-electric propulsion, turbine propulsion or hybrid propulsion systems.

### 1.3 Limited scope of the first issue of Industry Guidelines

This issue of the Industry Guidelines only applies to the following types of ships:

- Bulk carriers
- Gas carriers
- Tankers
- Containerships
- General cargo ships
- Refrigerated cargo carriers
- Combination carriers

which are not fitted with innovative energy efficient technologies.

The first issue of this document doesn't consider the EEDI verification after a major conversion. Guidelines on this subject will be developed subsequent to IMO's adoption of an interpretation of the definition of major conversion.

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## Part II - Explanatory notes on calculation of EEDI

### 2 INTRODUCTION

The attained Energy Efficiency Design Index (EEDI) is a measure of a ship's energy efficiency determined as follows:

$$EEDI = \frac{CO_2 \text{ emission}}{\text{Transport work}}$$

The CO<sub>2</sub> emission is computed from the fuel consumption taking into account the carbon content of the fuel. The fuel consumption is based on the power used for propulsion and auxiliary power measured at defined design conditions.

The transport work is estimated by the designed ship capacity multiplied by the ship's speed measured at the maximum summer load draught and at 75 per cent of the rated installed power.

### 3 EEDI FORMULA

The EEDI is provided by the following formula:

$$\frac{(\prod_{j=1}^n f_j) \cdot (\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}) + P_{AE} \cdot C_{FAE} \cdot SFC_{AE} + \{(\prod_{j=1}^n f_j) \cdot \sum_{i=1}^{n_{PTI}} P_{PTI(i)} - \sum_{i=1}^{n_{eff}} f_{eff(i)} \cdot P_{AEff(i)}\} \cdot C_{FAE} \cdot SFC_{AE} - \sum_{i=1}^{n_{eff}} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}}{f_i \cdot f_c \cdot \text{Capacity} \cdot f_w \cdot V_{ref}}$$

With the following Notes:

The global  $f_i$  factor may also be written:

$$f_i = (\prod_{i=1}^m f_i)$$

where each individual  $f_i$  factor is explained under section 9 of this document.

If part of the normal maximum sea load is provided by shaft generators, the term

$P_{AE} \cdot C_{FAE} \cdot SFC_{AE}$  may be replaced by:

$$(P_{AE} - 0.75 * \sum_{i=1}^{n_{PTO}} P_{PTO(i)}) \cdot C_{FAE} \cdot SFC_{AE} + 0.75 * \sum_{i=1}^{n_{PTO}} P_{PTO(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$$

with the condition  $0.75 * \sum_{i=1}^{n_{PTO}} P_{PTO(i)} \leq P_{AE}$

Where the total propulsion power is limited by verified technical means as indicated under section 6, the term  $(\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} + \sum_{i=1}^{n_{PTI}} P_{PTI(i)} \cdot C_{FAE} \cdot SFC_{AE})$  is to be replaced by 75 percent of the limited total propulsion power multiplied by the average weighted value of  $(SFC_{ME} \cdot C_{FME})$  and  $(SFC_{AE} \cdot C_{FAE})$

Due to the uncertainties in the estimation of the different parameters, the accuracy of the calculation of the attained EEDI cannot be better than 1%.

Therefore, the values of attained and required EEDI have to be reported with no more than three significant figures (for instance, 2.23 or 10.3) and the checking of Regulation 20, chapter 4 of MARPOL Annex VI has to be verified in accordance with this accuracy.

### 4 FUEL CONSUMPTION AND CO<sub>2</sub> EMISSION

The conversion factor  $C_F$  and the specific fuel consumption, SFC, are determined from the results recorded in the parent engine Technical File as defined in paragraph 1.3.15 of the NOx Technical Code 2008.

The fuel grade used during the test of the engine in the test bed measurement of SFC determines the value of the  $C_F$  conversion factor according to the table under 2.1 of the IMO Calculation Guidelines.

SFC is the corrected specific fuel consumption, measured in g/kWh, of the engines. The subscripts ME(i) and AE(i) refer to the main and auxiliary engine(s), respectively.  $SFC_{AE}$  is the power-weighted average among  $SFC_{AE(i)}$  of the respective engines  $i$ .

For main engines certified to the E2 or E3 test cycles of the NOx Technical Code 2008, the engine Specific Fuel Consumption ( $SFC_{ME(i)}$ ) is that recorded in the test report included in a NOx Technical File for the parent engine(s) at 75% of MCR power.

For engines certified to the D2 or C1 test cycles of the NOx Technical Code 2008, the engine Specific Fuel Consumption ( $SFC_{AE(i)}$ ) is that recorded in the test report included in a NOx Technical File for the parent engine(s) at 50% of MCR power or torque rating.

The SFC is to be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil (42,700kJ/kg), referring to ISO 15550:2002 and ISO 3046-1:2002.

For LNG driven engines for which SFC is measured in kJ/kWh, the SFC value is to be converted to g/kWh using the standard lower calorific value of the LNG (48,000 kJ/kg), referring to the 2006 IPCC Guidelines.

For those engines which do not have a test report included in a NOx Technical File because its power is below 130 kW, the SFC specified by the manufacturer is to be used.

At the design stage, in case of unavailability of test reports in the NOx Technical File, the SFC value given by the manufacturer with the addition of the guarantee tolerance is to be used.

## 5 CAPACITY, POWER AND SPEED

### 5.1 Capacity

The capacity of the ship is computed as a function of the deadweight as indicated under 2.3 of the IMO Calculation Guidelines.

For the computation of the deadweight according to 2.4 of the IMO Calculation Guidelines, the lightweight of the ship and the displacement at the summer load draught are to be based on the results of the inclining test or lightweight check provided in the final stability booklet. At the design stage, the deadweight may be taken in the provisional documentation.

### 5.2 Power

The installed power for EEDI determination is taking into account the propulsion power and in general a fixed part of the auxiliary power, measured at the output of the main or auxiliary engine.

The total propulsion power is defined as 75% MCR of all main engines.

The total shaft propulsion power (power delivered to propellers  $P_s$ ) is conventionally taken as follows:

$$\sum_{i=1}^{nME} P_{ME(i)} + \sum_{i=1}^{nPTI} (P_{PTI(i)} \cdot \eta_{PTI(i)}) \cdot \overline{\eta_{Gen}}$$

In this formula:

- The value of  $P_{ME(i)}$  may be limited by verified technical means (see 6 below)
- The total shaft propulsion power may be limited by verified technical means. In particular an electronic engine control system may limit the total propulsion power, whatever the number of engines in function (see 6 below)

The auxiliary power can be nominally defined as a specified proportion of main engine power aiming to cover normal maximum sea load for propulsion and accommodation<sup>1</sup>. The nominal values are 2.5% of main engine power plus 250 kW for installed main engine power equal to or above 10 MW. 5% of  $P_{ME}$  will be accounted if less than 10 MW main engine power is installed. Alternatively, as explained below, the value for auxiliary power can be taken from the power balance table for the ship.

In addition, if shaft motors are installed, then in principle 75% of the shaft motor power is accounted for in the EEDI calculation. Detailed explanation about this is given in section 6.

For a ship where the  $P_{AE}$  value calculated by paragraph 2.5.6.1 or 2.5.6.2 of the IMO Calculation Guidelines is significantly different from the total power used at normal seagoing operations, as an option if the difference leads to a variation of the computed value of the EEDI exceeding 1%, the  $P_{AE}$  value could be estimated by the electric power (excluding propulsion) in conditions when the ship is engaged in a voyage at reference speed ( $V_{ref}$ ) as given in the electric power table (EPT), divided by the average efficiency of the generator(s) weighted by power.

### 5.3 Speed $V_{ref}$

The speed  $V_{ref}$  is the ship speed, measured in knots, verified during sea trials and corrected to be given in the following conditions:

- in deep water
- assuming the weather is calm with no wind, no current and no waves
- in the loading condition corresponding to the Capacity
- at the total shaft propulsion power defined in 5.2 taking into account shaft generators and shaft motors

## 6 SHAFT GENERATOR AND SHAFT MOTOR

### 6.1 Introduction and background

Ships need electrical power for the operation of engine auxiliary systems, other systems, crew accommodation and for any cargo purposes. This electrical power can be generated by diesel-generator sets (gen-sets), shaft generators, waste heat recovery systems driving a generator and possibly by new innovative technologies, e.g. solar panels. Diesel-generator sets and shaft generators are the most common systems. While diesel-generator sets use a diesel engine powering a generator, a shaft generator is driven by the main engine. It is considered that due to the better efficiency of the main engine and efficiency of the shaft generator less  $CO_2$  is emitted compared to gen-set operation.

The EEDI formula expresses the propulsion power of a vessel as 75% of the main engine power  $P_{ME}$ . It is also termed shaft power  $P_S$ , which corresponds to the ship's speed  $V_{ref}$  in the EEDI formula.

$P_{AE}$  - the auxiliary power - is also included in the EEDI formula. However, this power demand is largely dependent on loading and trading patterns and it must also incorporate safety aspects, for example, the provision of a spare generator set. As noted in section 5, the auxiliary power can generally be taken into account as a fixed proportion of the main engine power (i.e. nominally 2.5% plus 250kW)<sup>2</sup>.

The use of shaft generators is a well proven and often applied technology, particularly for high electrical power demands related to the payload e.g. reefer containers. Usually a ship design implements a main engine to reach the envisaged speed with some provision of sea margin. For the use of a shaft generator past practice and understanding was to install a

<sup>1</sup> by paragraph 2.5.6.1 or 2.5.6.2 of the IMO Calculation Guidelines

<sup>2</sup> c.f.: precise instruction in IMO Calculation Guidelines



bigger main engine to reach the same speed compared to the design without a shaft generator and to then have the excess power available from the main engine at any time for generation of electrical power. As a rule of thumb, one more cylinder was added to the main engine to cover this additional power demand.

The difficulty with this issue for calculation of the EEDI is that the excess power could be used to move the ship faster in the case where the shaft generator is not in use which would produce a distortion between ship designs which are otherwise the same.

The IMO Calculation Guidelines take these circumstances into account and offer options for the use of shaft generators. These options are described in detail, below.

Further, electric shaft motors operate similarly to shaft generators; sometimes a shaft generator can act as a shaft motor. The possible influence of shaft motors has also been taken into account in the IMO Calculation Guidelines and is also illustrated, below.

## 6.2 Main engine power without shaft generators

The main engines are solely used for the ship's propulsion. For the purpose of the EEDI, the main engine power is 75 % of the rated installed power  $MCR_{ME}$  for each main engine:

$$P_{ME(i)} = 0.75 \times MCR_{ME(i)}$$

## 6.3 Main engine power with shaft generators

Shaft generators produce electric power using power from the prime mover (main engine). Therefore the power used for the shaft generator is not available for the propulsion. Hence  $MCR_{ME}$  is the sum of the power needed for propulsion and the power needed for the shaft generator. Thus at least a part of the shaft generator's power should be deductible from the main engine power ( $P_{ME}$ ).

The power driving the shaft generator is not only deducted in the calculation. As this power is not available for propulsion this yields a reduced reference speed. The speed is to be determined from the power curve obtained at the sea trial as explained in the schematic figure provided in paragraph 2.5 of the IMO Calculation Guidelines.

It has been defined that 75% of the main engine power is entered in the EEDI calculation. To induce no confusion in the calculation framework, it has therefore also been defined to take into account 75% of the shaft power take off / take in (as electrical power [kW] as displayed on the name plate of the shaft generator/motor).

For the calculation of the effect of shaft generators, two options are available.

### 6.3.1 Option 1

For this option,  $P_{PTO(i)}$  is defined as 75% of the rated electrical output power  $MCR_{PTO}$  of each shaft generator. The maximum allowable deduction is limited by the auxiliary power  $P_{AE}$  as described in Paragraph 2.6 in the IMO Calculation Guidelines.

Then the main engine power  $P_{ME}$  is:

$$P_{PTO(i)} = 0.75 \times MCR_{PTO(i)}$$

$$\sum P_{ME(i)} = 0.75 \times \sum (MCR_{ME(i)} - P_{PTO(i)}) \text{ with } 0.75 \times \sum P_{PTO(i)} \leq P_{AE}$$

This means, that only the maximum amount of shaft generator power that is equal to  $P_{AE}$  is deductible from the main engine power. In doing so, 75% of the shaft generator power must be greater than the auxiliary power calculated in accordance to Para. 2.6. of the IMO Calculation Guidelines.

Higher shaft generators output than  $P_{AE}$  will not be accounted for under option 1.



### 6.3.2 Option 2

The main engine power  $P_{ME}$  to be considered for the calculation of the EEDI is defined as 75% of the power to which the propulsion system is limited. This can be achieved by any verified technical means, e.g. by electronic engine controls.

$$P_{ME(i)} = 0.75 \times P_{Shaft,limit}$$

This option is to cover designs with the need for very high power requirements (e.g., pertaining to the cargo). With this option it is ensured that the higher main engine power cannot be used for a higher ship speed. This can be safeguarded by the use of verified technical devices limiting the power to the propulsor.

For example, consider a ship having a 15 MW main engine with a 3 MW shaft generator. The shaft limit is verified to 12 MW. The EEDI is then calculated with only 75% of 12 MW as main engine power as, in any case of operation, no more power than 12 MW can be delivered to the propulsor, irrespective of whether a shaft generator is in use or not.

It is to be noted that the guidelines do not stipulate any limits as to the value of the shaft limit in relation to main engine power or shaft generator power.

### 6.3.3 The use of specific fuel oil consumption and $C_F$ -factor

Shaft generators are driven by the main engine, therefore the specific fuel oil consumption of the main engine is allowed to be used to the full extent if 75% of the shaft generator power is equal to  $P_{AE}$ .

In the case shaft generator power is less than  $P_{AE}$  then 75% of the shaft generator power is calculated with the main engine's specific fuel oil consumption and the remaining part of the total  $P_{AE}$  power is calculated with SFC of the auxiliaries ( $SFC_{AE}$ ).

The same applies to the conversion factor  $C_F$ , if different fuels are used in the EEDI calculation.

### 6.4 Total shaft power with shaft motors

In the case where shaft motor(s) are installed, the same guiding principles as explained for shaft generators, above, apply. But in contrast to shaft generators, motors do increase the total power to the propulsor and do increase ships' speed and therefore must be included in the total shaft power within the EEDI calculation. The total shaft power is thus main engine(s) power plus the additional shaft motor(s) power:

$$\sum P_{ME(i)} + \sum P_{PTI(i),Shaft}$$

Where:

$$\sum P_{PTI(i),Shaft} = \sum (0.75 \cdot P_{SM,max(i)} \cdot \eta_{PTI(i)})$$

Similar to the shaft generators, only 75% of the rated power consumption  $P_{SM,max}$  (i.e. rated motor output divided by the motor efficiency) of each shaft motor divided by the weighted average efficiency of the generator(s)  $\eta_{Gen}$  is taken into account for EEDI calculation.<sup>3</sup>

<sup>3</sup> The efficiency of shaft generators in the previous section has consciously not been taken into account in the denominator as inefficient generator(s) would increase the deductible power.

$$\sum P_{PTI(i)} = \frac{\sum (0.75 \cdot P_{SM,max(i)})}{\eta_{Gen}}$$

A power limitation similar to that described above for shaft generators can also be used for shaft motors. So if a verified technical measure is in place to limit the propulsion output, only 75% of limited power is to be used for EEDI calculation and also for that limited power  $V_{ref}$  is determined.

A diagram is inserted to highlight where the mechanical and electrical efficiencies or the related devices (PTI and Generator's) are located:

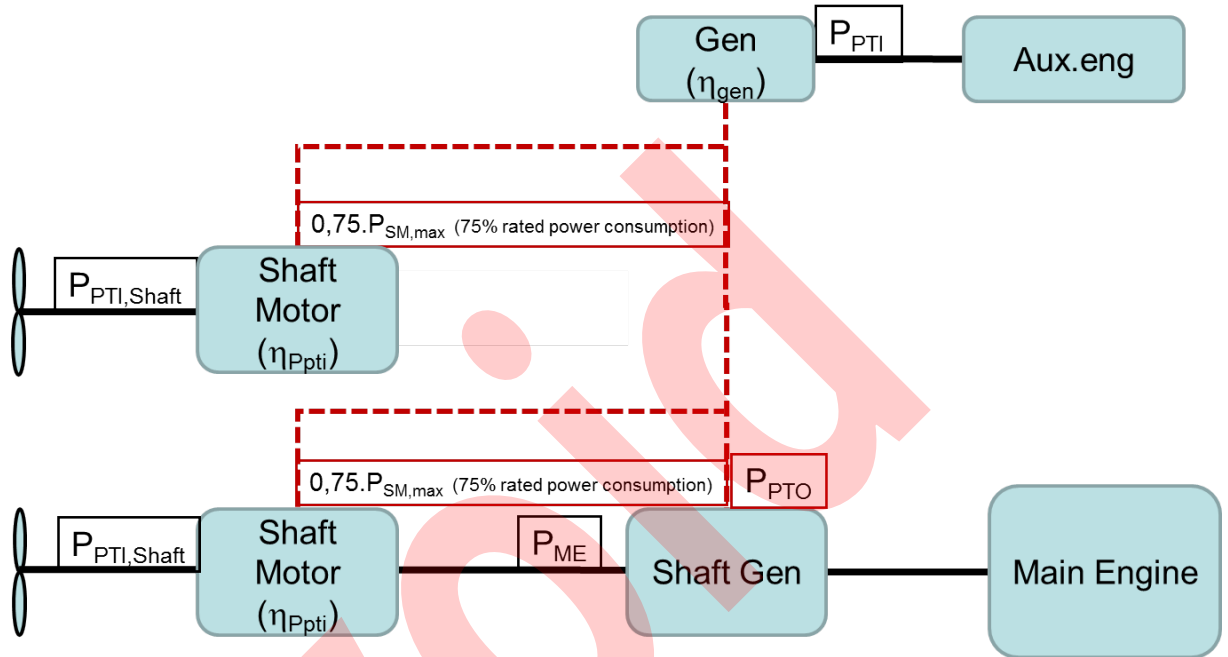


Figure 1: Typical arrangement of propulsion and electric power system

## 6.5 Calculation examples

For these calculation examples the ships' following main parameters are set as:

$$MCR_{ME} = 20,000 \text{ kW}$$

$$Capacity = 20,000 \text{ DWT}$$

$$C_{F,ME} = 3.206$$

$$C_{F,AE} = 3.206$$

$$SFC_{ME} = 190 \text{ g/kWh}$$

$$SFC_{AE} = 215 \text{ g/kWh}$$

$$v_{ref} = 20 \text{ kn (without shaft generator/motor)}$$

### 6.5.1 One main engine, no shaft generator

$$MCR_{ME} = 20,000 \text{ kW}$$

$$P_{ME} = 0.75 \times MCR_{ME} = 0.75 \times 20,000 \text{ kW} = 15,000 \text{ kW}$$

$$P_{AE} = (0.025 \times 20,000) + 250 \text{ kW} = 750 \text{ kW}$$

$$EEDI = ((15,000 \times 3.206 \times 190) + (750 \times 3.206 \times 215)) / (20 \times 20,000) \\ = 24.1 \text{ g CO}_2 / tnm$$

### 6.5.2 One main engine, $0.75 \times P_{PTO} < P_{AE}$ , option 1

$$MCR_{PTO} = 500kW$$

$$P_{PTO} = 500kW \times 0.75 = 375kW$$

$$MCR_{ME} = 20,000kW$$

$$P_{ME} = 0.75 \times (MCR_{ME} - P_{PTO}) = 0.75 \times (20,000kW - 375kW) = 14,719kW$$

$$P_{AE} = (0.025 \times MCR_{ME}) + 250kW = 750kW$$

$$v_{ref} = 19.89kn : \text{ The speed at } P_{ME} \text{ determined from the power curve}$$

$$EEDI = \left( (P_{ME} \times C_{F,ME} \times SCF_{ME}) + (0.75 \times P_{PTO} \times C_{F,ME} \times SCF_{ME}) + ((P_{AE} - 0.75 \times P_{PTO}) \times C_{F,AE} \times SFC_{AE}) \right) / (DWT \times v_{ref})$$

$$= 23.8 \text{ g CO}_2 / t \text{ nm} \approx 1\%$$

### 6.5.3 One main engine, $0.75 \times P_{PTO} = P_{AE}$ , option 1

$$MCR_{PTO} = 1,333kW$$

$$P_{PTO} = 1,333kW \times 0.75 = 1,000kW$$

$$MCR_{ME} = 20,000kW$$

$$P_{ME} = 0.75 \times (MCR_{ME} - P_{PTO}) = 0.75 \times (20,000kW - 1,000kW) = 14,250kW$$

$$P_{AE} = (0.025 \times MCR_{ME}) + 250kW = 750kW$$

$$v_{ref} = 19.71kn : \text{ The speed at } P_{ME} \text{ determined from the power curve}$$

$$EEDI = \left( (P_{ME} \times C_{F,ME} \times SCF_{ME}) + (0.75 \times P_{PTO} \times C_{F,ME} \times SCF_{ME}) \right) / (DWT \times v_{ref})$$

$$= 23.2 \text{ g CO}_2 / t \text{ nm} \approx 4\%$$

### 6.5.4 One main engine with shaft generator, $0.75 \times P_{PTO} > P_{AE}$ , option 1

$$MCR_{PTO} = 2,000kW$$

$$0.75 \times P_{PTO} = 0.75 \times 2,000kW \times 0.75 = 1,125kW > P_{AE} \Rightarrow P_{PTO} = P_{AE} / 0.75 = 1,000kW$$

$$MCR_{ME} = 20,000kW$$

$$P_{ME} = 0.75 \times (MCR_{ME} - P_{PTO}) = 0.75 \times (20,000kW - 1,000kW) = 14,250kW$$

$$P_{AE} = (0.025 \times MCR_{ME}) + 250kW = 750kW$$

$$v_{ref} = 19.71kn : \text{ The speed at } P_{ME} \text{ determined from the power curve}$$

$$EEDI = \left( (P_{ME} \times C_{F,ME} \times SCF_{ME}) + (0.75 \times P_{PTO} \times C_{F,ME} \times SCF_{ME}) \right) / (DWT \times v_{ref})$$

$$= 23.2 \text{ g CO}_2 / t \text{ nm} \approx 4\%$$

### 6.5.5 One main engine with shaft generator, $0.75 \times P_{PTO} > P_{AE}$ , option 2

$$MCR_{PTO} = 2,000kW$$

$$MCR_{ME} = 20,000kW$$

$$P_{Shaft,limit} = 18,000kW$$

$$P_{ME} = 0.75 \times (P_{Shaft,limit}) = 0.75 \times (18,000kW) = 13,500kW$$

$$P_{AE} = (0.025 \times MCR_{ME}) + 250kW = 750kW$$

$$v_{ref} = 19.41kn : \text{ The speed at } P_{ME} \text{ determined from the power curve}$$

$$EEDI = \left( (P_{ME} \times C_{F,ME} \times SFC_{ME}) + (P_{AE} \times C_{F,ME} \times SFC_{ME}) \right) / (DWT \times v_{ref})$$

$$= 22.4 \text{ g CO}_2 / t \text{ nm} \approx 7\%$$

### 6.5.6 One main engine, one shaft motor

$$MCR_{ME} = 18,000kW$$

$$P_{ME} = 0.75 \times MCR_{ME} = 0.75 \times 18,000kW = 13,500kW$$

$$P_{AE} = \left\{ 0.025 \times \left( MCR_{ME} + \frac{P_{PTI}}{0.75} \right) \right\} + 250kW = \left\{ 0.025 \times \left( 18,000 + \frac{1612.9}{0.75} \right) \right\} + 250kW = 754kW$$

$$P_{SM,max} = 2,000kW$$

$$P_{PTI} = 0.75 \times P_{SM,max} / \eta_{Gen} = 1,612.9kW$$

$$\eta_{PTI} = 0.97$$

$$\eta_{Gen} = 0.93$$

$$P_{Shaft} = P_{ME} + P_{PTI,Shaft} = P_{ME} + (P_{PTI} \cdot \eta_{PTI}) \cdot \eta_{Gen} = 13,500kW + (1612.9 \cdot 0.97) \cdot 0.93 = 14,955kW$$

$$v_{ref} = 20kn$$

$$EEDI = \left( (P_{ME} \times C_{F,ME} \times SFC_{ME}) + (P_{AE} \times C_{F,AE} \times SFC_{AE}) + (P_{PTI} \times C_{F,AE} \times SFC_{AE}) \right) / (DWT \times v_{ref})$$

$$= 24.6 \text{ g CO}_2 / t \cdot nm \approx -2\%$$

## 7 WEATHER FACTOR $f_w$

$f_w$  is a non-dimensional coefficient indicating the decrease of speed in representative sea conditions of wave height, wave frequency and wind speed (e.g. Beaufort Scale 6), and is taken as 1.0 for the calculation of attained EEDI.

When a calculated  $f_w$  is used, the attained EEDI using calculated  $f_w$  is to be presented as "attained EEDI<sub>weather</sub>" in order to clearly distinguish it from the attained EEDI under regulations 20 and 21 in MARPOL Annex VI.

Guidelines for the calculation of the coefficient  $f_w$  for the decrease of ship speed in respective sea conditions will be developed.

## 8 CORRECTION FACTOR FOR SHIP SPECIFIC DESIGN ELEMENTS $f_j$

Except in the cases listed below, the value of the  $f_j$  factor is 1.0.

For Finnish-Swedish ice class notations or equivalent notations of the Classification Societies, the  $f_j$  correction factor is indicated in Table 1 under 2.8.1 of the IMO Calculation Guidelines.<sup>4</sup>

For shuttle tankers with propulsion redundancy defined as oil tankers between 80,000 and 160,000 deadweight equipped with dual-engines and twin-propellers and assigned the class notations covering dynamic positioning and propulsion redundancy, the  $f_j$  factor is to be 0.77.

The total shaft propulsion power of shuttle tankers with redundancy is usually not limited by verified technical means.

## 9 CAPACITY FACTOR $f_i$

Except in the cases listed below, the value of the  $f_i$  factor is 1.0.

For Finnish-Swedish ice class notations or equivalent notations of the Classification Societies, the  $f_i$  correction factor is indicated in Table 2 under 2.11.1 of the IMO Calculation Guidelines.<sup>4</sup>

<sup>4</sup> Tables 1 and 2 in IMO Calculation Guidelines refer to Finnish/Swedish ice classed ships usually trading in the Baltic Sea. Justified alternative values for  $f_i$  and  $f_j$  factors may be accepted for ice-classed ships outside this scope of application (e.g. very large ships or POLAR CLASS)

For a ship with voluntary structural enhancement, the  $f_{IVSE}$  factor is to be computed according to 2.11.2 of the IMO Calculation Guidelines.

For bulk carriers and oil tankers built in accordance with the Common Structural Rules and assigned the class notation CSR, the  $f_{ICSR}$  factor is to be computed according to 2.11.3 of the IMO Calculation Guidelines.

$f_i$  capacity factors can be cumulated (multiplied), but the reference design for calculation of  $f_{IVSE}$  is to comply with the ice notation and/or Common Structural Rules as the case may be.

## 10 CUBIC CAPACITY CORRECTION FACTOR $f_c$

Except in the cases listed below, the value of the  $f_c$  factor is 1.0.

For chemical tankers as defined in regulation 1.16.1 of MARPOL Annex II, the  $f_c$  factor is to be computed according to 2.12.1 of the IMO Calculation Guidelines.

For gas carriers as defined in regulation 1.1 of IGC Code having direct diesel driven propulsion, the  $f_c$  factor is to be computed according to 2.12.2 of the IMO Calculation Guidelines.

## 11 INNOVATIVE ENERGY EFFICIENT TECHNOLOGIES

Innovative energy efficient technologies are not taken into account in the first version of this document (see 1.3)

## 12 EXAMPLE OF CALCULATION

### 12.1 List of input parameters for calculation of EEDI

The input parameters used in the calculation of the EEDI are provided in Table 1.

The values of all these parameters are to be indicated in the EEDI Technical File and the documents listed in the “source” column are to be submitted to the verifier.

| Symbol      | Name                                                      | Usage                                       | Source                                                                                                 | Scope                               |
|-------------|-----------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------|
|             | Service notation                                          | Capacity, $f_i$ , $f_j$ and $f_c$ factors   |                                                                                                        | For the ship                        |
|             | Class notations                                           | $f_j$ for shuttle tanker, $f_{ICSR}$        | Classification file                                                                                    |                                     |
|             | Ice notation                                              | $f_i$ , $f_j$ for ice class                 |                                                                                                        |                                     |
| $L_{pp}$    | Length between perpendiculars (m)                         | $f_i$ , $f_j$ for ice class                 |                                                                                                        |                                     |
| $\Delta$    | Displacement @ summer load draught (t)                    | deadweight                                  | final stability file                                                                                   |                                     |
| LWT         | Lightweight (t)                                           | deadweight, $f_{IVSE}$ , $f_{ICSR}$ , $f_c$ | Sheets of Submitter calculation for lightweight <sub>referencedesign</sub><br>lightweight check report |                                     |
| $P_{AE}$    | Auxiliary engine power (kW)                               | EEDI                                        | Note: Computed from engines & PTIs powers or electric power table                                      |                                     |
| $V_{ref}$   | Reference speed (knot)                                    | EEDI                                        | Sea trial report                                                                                       |                                     |
| Cube        | Total cubic capacity of the cargo tanks (m <sup>3</sup> ) | $f_c$ for chemical tankers and gas carriers | Tonnage file                                                                                           | Per engine ( $n_{ME}$ + $n_{GEN}$ ) |
| MCR         | Rated installed power (kW)                                | power                                       | EIAPP certificate or nameplate (if less than 130 kW)                                                   |                                     |
| $MCR_{lim}$ | Limited rated output power after PTO in (kW)              | $P_{ME}$ with PTO option 2                  | Verification file                                                                                      |                                     |

| Symbol         | Name                                        | Usage                                              | Source                                  | Scope                      |
|----------------|---------------------------------------------|----------------------------------------------------|-----------------------------------------|----------------------------|
|                | Fuel grade                                  | $C_F$ , SFC                                        | NOX Technical File of the parent engine |                            |
| SFC            | Corrected specific fuel consumption (g/kWh) | EEDI                                               | NOx Technical File of the parent engine |                            |
| $MCR_{PTO}$    | Rated electrical output power (kW)          | $P_{ME}$                                           |                                         | Per shaft generator (nPTO) |
| $P_{SM,max}$   | Rated power consumption (kW)                | EEDI                                               |                                         | Per shaft motor (nPTI)     |
| $\eta_{PTI}$   | efficiency                                  | power                                              |                                         | Per generator (nGEN)       |
| $\eta_{GEN}$   | efficiency                                  | power                                              |                                         |                            |
| $P_{SHAFTlim}$ | Limited shaft propulsion power (kW)         | Limited power where means of limitation are fitted | Verification file                       | Per shaftline (nSHAFT)     |

Table 1: input parameters for calculation of EEDI

## 12.2 Sample calculation of EEDI

A sample calculation of EEDI is provided in Appendix 2.

## Part III - Verification of EEDI

### 13 VERIFICATION PROCESS

Attained EEDI is to be computed in accordance with the IMO Calculation Guidelines and Part II of the present Industry Guidelines. Survey and certification of the EEDI are to be conducted on two stages:

1. preliminary verification at the design stage
2. final verification at the sea trial

The flow of the survey and certification process is presented in Figure 2.

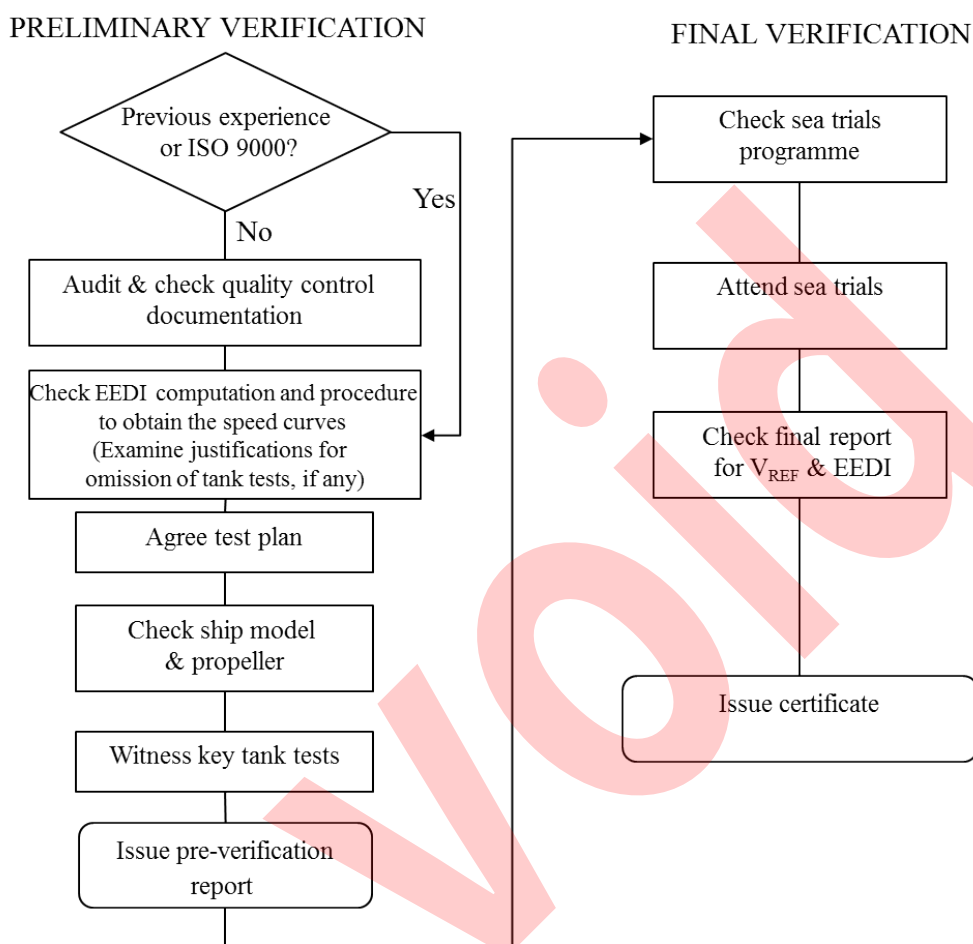


Figure 2: Flow of survey and certification process by verifier

### 14 DOCUMENTS TO BE SUBMITTED

A sample of document to be submitted to the verifier including additional information for verification is provided in Appendix 2.

The following information is to be submitted by the submitter to the verifier at the design stage:

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EEDI Technical File | EEDI Technical File as defined in the IMO Verification Guidelines. See example of the EEDI Technical File in Appendix 1 of IMO Verification Guidelines.                                                                                                                                                                                                                                                                                             |
| NOx Technical File  | Copy of the NOx Technical File and documented summary of the SFC correction for each type of main and auxiliary engine with copy of EIAPP certificate.<br>Note: if the NOx Technical File has not been approved at the time of the preliminary verification, the SFC value with the addition of the guarantee tolerance is to be provided by Manufacturer. In this case, the NOx Technical File is to be submitted at the final verification stage. |



|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electric Power Table                                                                          | If $P_{AE}$ is significantly different from the values computed using the formula in 2.5.6.1 or 2.5.6.2 of the IMO Calculation Guidelines                                                                                                                                                                                                                                                                                                                                                              |
| Ship lines and model particulars                                                              | - Lines of ship<br>- Report including the particulars of the ship model and propeller model                                                                                                                                                                                                                                                                                                                                                                                                            |
| Verification file of power limitation technical arrangement                                   | If the propulsion power is voluntarily limited by verified technical means                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Power curves                                                                                  | Power-speed curves predicted at full scale in sea trial condition and EEDI condition                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Description of the towing tank test facility and towing tank test organisation quality manual | If the verifier has no recent experience with the towing tank test facility and the towing tank test organization quality system is not ISO 9001 certified.<br>- Quality management system of the towing tank test including process control, justifications concerning repeatability and quality management processes<br>- Records of measuring equipment calibration as described in Appendix 3<br>- Standard model-ship extrapolation and correlation method (applied method and tests description) |
| Gas fuel oil general arrangement plan                                                         | If gas fuel is used as the primary fuel of the ship fitted with dual fuel engines. Gas fuel storage tanks (with capacities) and bunkering facilities are to be described.                                                                                                                                                                                                                                                                                                                              |
| Towing Tank Tests Plan                                                                        | Plan explaining the different steps of the towing tank tests and the scheduled inspections allowing the verifier to check compliance with the items listed in Appendix 1 concerning tank tests                                                                                                                                                                                                                                                                                                         |
| Towing Tank Tests Report                                                                      | - Report of the results of the towing tank tests at sea trial and EEDI condition as required in Appendix 4<br>- Values of the experience-based parameters defined in the standard model-ship correlation method used by the towing tank test organization/shipyard<br>- Reasons for exempting a towing tank test, only if applicable<br>- Numerical calculations report and validation file of these calculations, only if calculations are used to derive power curves                                |
| Ship reference speed $V_{ref}$                                                                | Detailed calculation process of the ship speed, which is to include the estimation basis of experience-based parameters such as roughness coefficient, wake scaling coefficient                                                                                                                                                                                                                                                                                                                        |

*Table 2: documents to be submitted at the design stage*

The following information is to be submitted by the submitter to the verifier at the final verification stage (and before the sea trials for the programme of sea trials):

|                             |                                                                                                                                                                    |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Programme of sea trials     | Description of the test procedure to be used for the speed trial, with number of speed points to be measured and indication of PTO/PTI to be in operation, if any. |
| Sea trials report           | Report of sea trials with detailed computation of the corrections allowing determination of the reference speed $V_{ref}$                                          |
| Final stability file        | Final stability file including lightweight of the ship and displacement table based on the results of the inclining test or the lightweight check                  |
| Final power curves          | Final power curve in the EEDI condition showing the speed adjustment methodology                                                                                   |
| Revised EEDI Technical File | Including identification of the parameters differing from the calculation performed at the initial verification stage                                              |
| Ship lines                  | Lines of actual ship                                                                                                                                               |

*Table 3: documents to be submitted at the final verification stage*

In line with the IMO Verification Guidelines (4.1.2), it is recognized that the documents listed above may contain confidential information of submitters, which requires Intellectual Property Rights (IPR) protection. In the case where the submitter wants a non-disclosure agreement with the verifier, the additional information is to be provided to the verifier upon mutually agreed terms and conditions.

## 15 PRELIMINARY VERIFICATION AT THE DESIGN STAGE

### 15.1 Scope of the verifier work

For the preliminary verification of the EEDI at the design stage, the verifier:

- Review the EEDI Technical File, check that all the input parameters (see 12.1 above) are documented and justified and check that the possible omission of a towing tank test has been properly justified
- Check that the ITTC procedures and quality system are implemented by the organization conducting the towing tank tests. The verifier should possibly audit the quality management system of the towing tank if previous experience is insufficiently demonstrated
- Witness the towing tank tests according to a test plan initially agreed between the submitter and the verifier
- Check that the work done by the towing tank test organisation is consistent with the present Guidelines. In particular, the verifier will check that the power curves at full scale are determined in a consistent way between sea trials and EEDI loading conditions, applying the same calculation process of the power curves and considering justifiable differences of experience based parameters between the two conditions
- Issue a pre-verification report

## 15.2 Definitions

*Experience-based parameters* means parameters used in the determination of the scale effects coefficients of correlation between the towing tank model scale results and the full scale predictions of power curves.

This may include:

1. Hull roughness correction
2. Wake correction factor
3. Air resistance correction factor (due to superstructures and deck load)
4. Appendages correction factor (for appendages not present at model scale)
5. Propeller cavitation correction factor
6. Propeller open-water characteristics correction
7.  $C_P$  and  $C_N$  (see below)
8.  $\Delta C_{FC}$  and  $\Delta w_C$  (see below)

*Ship of the same type* means a ship of which hull form (expressed in the lines such as sheer plan and body plan) excluding additional hull features such as fins and of which principal particulars are identical to that of the base ship.

Definition of survey methods directly involving the verifier: Review and Witness.

*Review* means the act of examining documents in order to determine identification and traceability and to confirm that requested information are present and that EEDI calculation process conforms to relevant requirements.

*Witness* means the attendance at scheduled key steps of the towing tank tests in accordance with the agreed Test Plan to the extent necessary to check compliance with the survey and certification requirements.

## 15.3 Towing tank tests and numerical calculations

There are two loading conditions to be taken into account for EEDI: EEDI loading condition and sea trial condition.

The speed power curves for these two loading conditions are to be based on towing tank test measurements. Towing tank test means model towing tests, model self-propulsion tests and model propeller open water tests.

Numerical calculations may be accepted as equivalent to model propeller open water tests.

A towing tank test for an individual ship may be omitted based on technical justifications such as availability of the results of towing tank tests for ships of the same type according to 4.2.5 of the IMO Verification Guidelines.

Numerical calculations may be submitted to justify derivation of speed power curves, where only one parent hull form have been verified with towing tank tests, in order to evaluate the effect of additional hull features such as fore bulb variations, fins and hydrodynamic energy saving devices.

These numerical tests may include CFD calculation of propulsive efficiency at reference speed  $V_{ref}$  as well as hull resistance variations and propeller open water efficiency.

In order to be accepted, these numerical tests are to be carried out in accordance with defined quality and technical standards (ITTC 7.5-03-01-04 at its latest revision or equivalent). The comparison of the CFD-computed values of the unmodified parent hull form with the results of the towing tank tests must be submitted for review.

#### **15.4 Qualification of verifier personnel**

Surveyors of the verifier are to confirm through review and witness as defined in 15.2 that the calculation of EEDI is performed according to the relevant requirements listed in 1.1. The surveyors are to be qualified to be able to carry out these tasks and procedures are to be in place to ensure that their activities are monitored.

#### **15.5 Review of the towing tank test organisation quality system**

The verifier is to familiarize with the towing tank test organization test facilities, measuring equipment and quality system for consideration of complying with the requirements of 15.6 prior to the test attendance when the verifier has no recent experience of the towing tank test facilities and the towing tank test organization quality control system is not certified according to a recognized scheme (ISO 9001 or equivalent).

In this case, the following additional information relative to the towing tank test organization is to be submitted to the verifier:

1. descriptions of the towing tank test facility; this includes the name of the facility, the particulars of towing tanks and towing equipment, and the records of calibration of each monitoring equipment as described in Appendix 3
2. quality manual containing at least the information listed in the ITTC Sample quality manual (2002 issue) Records of measuring equipment calibration as described in Appendix 3
3. standard model-ship extrapolation and correlation method (applied method and tests description)

#### **15.6 Review and Witness**

The verifier is to review the EEDI Technical File, using also the other documents listed in table 2 and submitted for information in order to verify the calculation of EEDI at design stage. This review activity is described in Appendix 1. Since detailed process of the towing tank tests depends on the practice of each submitter, sufficient information is to be included in the document submitted to the verifier to show that the principal scheme of the towing tank test process meets the requirements of the reference documents listed in Appendix 1 and Appendix 4.

Prior to the start of the towing tank tests, the submitter is to submit a test plan to the verifier. The verifier reviews the test plan and agrees with the submitter which scheduled inspections will be performed with the verifier surveyor in attendance in order to perform the verifications listed in Appendix 1 concerning the towing tank tests.

Following the indications of the agreed test plan, the submitter will notify the verifier for the agreed tests to be witnessed. The submitter will advise the verifier of any changes to the

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activities agreed in the Test Plan and provide the submitter with the towing tank test report and results of trial speed prediction.

### 15.7 Model-ship correlation

Model-ship correlation method followed by the towing tank test organization or shipyard is to be properly documented with reference to the 1978 ITTC Trial prediction method given in ITTC Recommended Procedure 7.5-02-03-1.4 rev.02 of 2011 or subsequent revision, mentioning the differences between the followed method and the 1978 ITTC trial prediction method and their global equivalence.

Considering the formula giving the total full scale resistance coefficient of the ship with bilge keels and other appendages:

$$C_{TS} = \frac{S_S + S_{BK}}{S_S} \cdot [(1 + k) \cdot C_{FS} + \Delta C_F + C_A] + C_R + C_{AAS} + C_{Apps}$$

The way of calculating the form factor  $k$ , the roughness allowance  $\Delta C_F$ , the correlation allowance  $C_A$ , the air resistance coefficient  $C_{AAS}$  and the appendages coefficient  $C_{Apps}$  are to be documented (if they are taken as 0, this has to be indicated also), as indicated in Appendix 4.

The correlation method used is to be based on thrust identity and the correlation factors is to be according to method 1 ( $C_P - C_N$ ) or method 2 ( $\Delta C_{FC} - \Delta w_C$ ) of the 1978 ITTC Trial prediction method. If the standard method used by the towing tank test organization doesn't fulfil these conditions, an additional analysis based on thrust identity is to be submitted to the verifier.

The verifier will check that the power-speed curves obtained for the EEDI condition and sea trial condition are obtained using the same calculation process and properly documented as requested in Appendix 4 "Witnessing of model test procedures". In particular, the verifier will compare the differences between experience based coefficients  $C_p$  and  $\Delta C_{FC}$  between the EEDI condition ( $\nabla_{full}$ ) and sea trial condition if different from EEDI condition ( $\nabla$ ) with the indications given in Figures 3.1 and 3.2 extracted from a SAJ-ITTC study on a large number of oil tankers. If the difference is significantly higher than the values reported in the Figures, a proper justification of the values is to be submitted to the verifier.

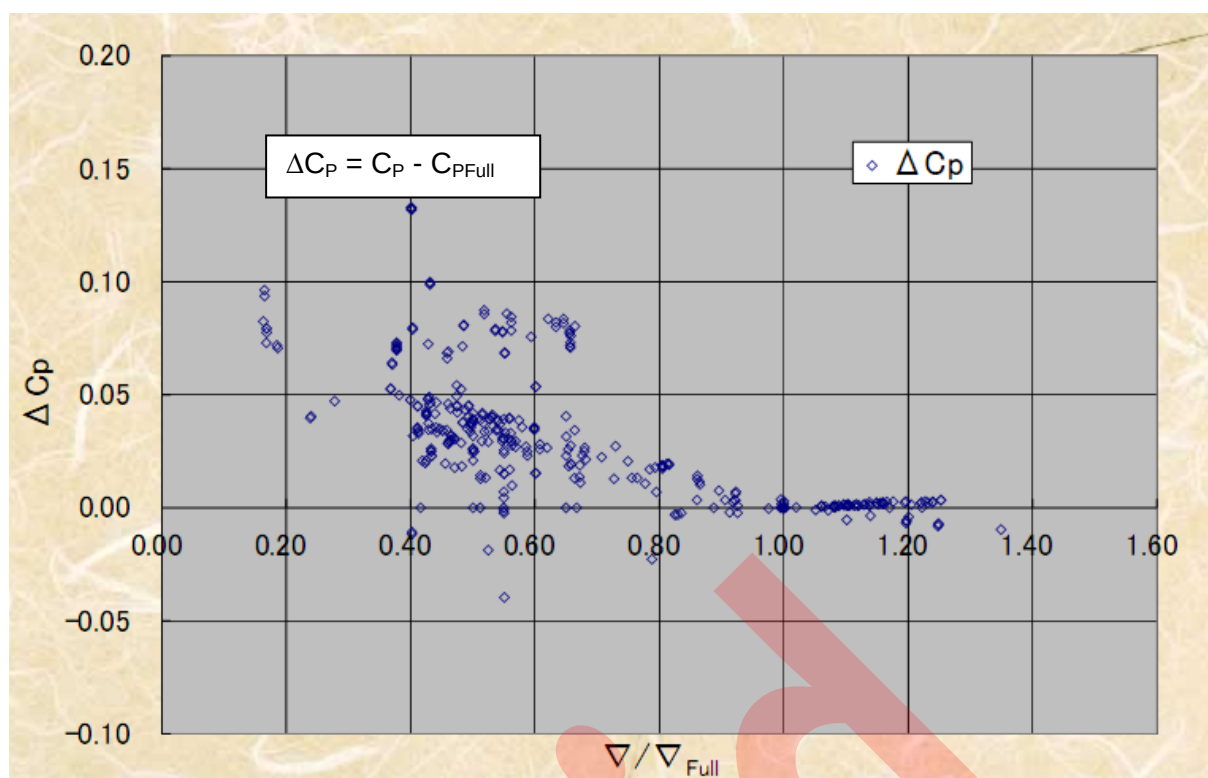


Figure 3.1: Variation of  $C_P - C_{P_{Full}}$  as a function of the displacement ratio

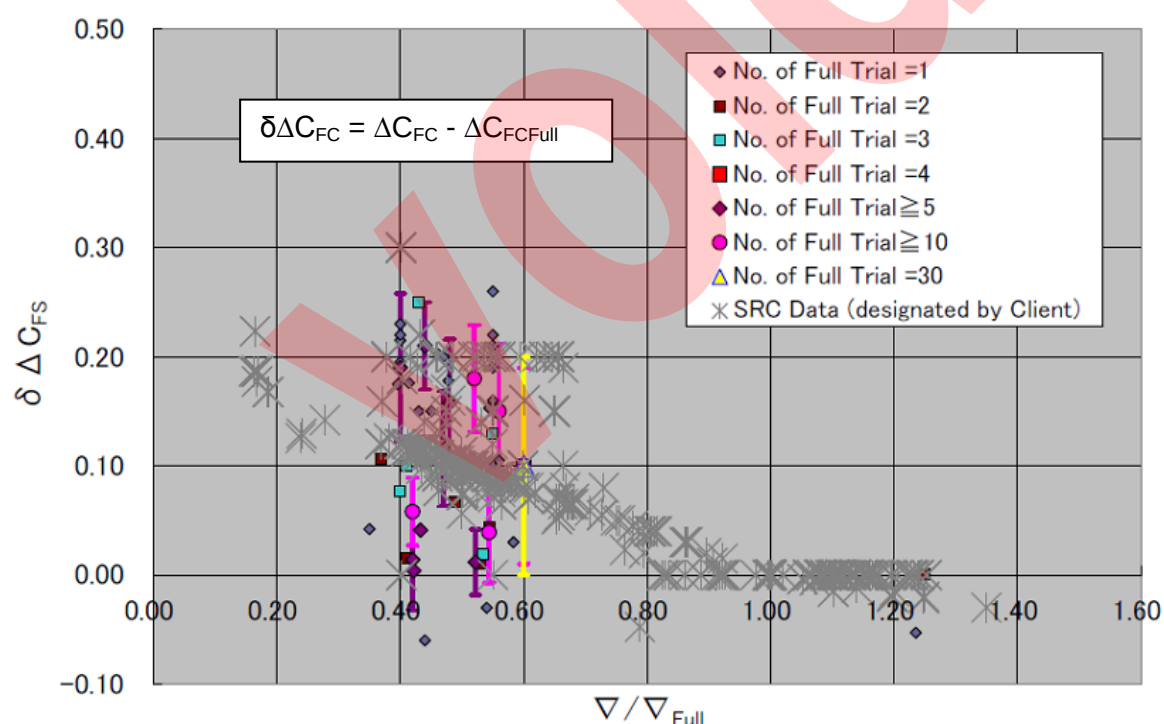


Figure 3.2: Variation of  $\Delta C_{FC}$  as a function of the displacement ratio

### 15.8 Pre-verification report

The verifier issues the report on the "Preliminary Verification of EEDI" after it has verified the attained EEDI at the design stage in accordance with paragraphs 4.1 and 4.2 of the IMO Verification Guidelines.

A sample of the report on the "Preliminary Verification of EEDI" is provided in Appendix 5.

## 16 FINAL VERIFICATION AT SEA TRIAL

### 16.1 Sea trial procedure

For the verification of the EEDI at sea trial stage, the verifier shall:

- Examine the programme of the sea trial to check that the test procedure and in particular that the number of speed measurement points comply with the requirements of the IMO Verification Guidelines.
- Perform a survey to ascertain the machinery characteristics of some important electric load consumers and producers included in the EPT, if the power  $P_{AE}$  is directly computed from the EPT data's.
- Attend the sea trial and notes the main parameters to be used for the final calculation of the EEDI, as given under 4.3.3 of the IMO Verification Guidelines
- Review the sea trial report provided by the submitter and check that the measured power and speed have been corrected according to ITTC Recommended Procedure 7.5-04-01-01.2 or the equivalent (see note).
- Check that the power curve estimated for EEDI condition further to sea trial is obtained by power adjustment.
- Review the revised EEDI Technical File.
- Issue or endorse the International Energy Efficiency Certificate

Note: For application of the present Guidelines the following procedures are considered wholly or partly (according to their scope) equivalent to ITTC Recommended Procedure 7.5-04-01-01.2 :

1. ISO 15016:2002
2. BSRA Standard method of speed trials analysis – BSRA report 486 / 1976

Table 5 lists the data which are to be measured and recorded during sea trials:

| Symbol      | Name                                            | Measurement                                                                                                                                                     | Remark |
|-------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
|             | Time and duration of sea trial                  |                                                                                                                                                                 |        |
|             | Draft marks readings                            |                                                                                                                                                                 |        |
|             | Air and sea temperature                         |                                                                                                                                                                 |        |
|             | Main engine setting                             | Machinery log                                                                                                                                                   |        |
| $\Psi_0$    | Course direction (rad)                          | Compass                                                                                                                                                         |        |
| $V_G$       | Speed over ground (m/s)                         | GPS                                                                                                                                                             |        |
| $n$         | Propeller rpm (rpm)                             | Tachometer                                                                                                                                                      |        |
| $P_S$       | Power measured (kW)                             | Torsion meter or strain gauges (for torque measurement) or any alternative method that offer an equivalent level of precision and accuracy of power measurement |        |
| $V_{WR}$    | Relative wind velocity (m/s)                    | Wind indicator                                                                                                                                                  |        |
| $\Psi_{WR}$ | Relative wind direction (rad)                   | See above                                                                                                                                                       |        |
| $T_m$       | Mean wave period (seas and swell) (s)           | Visual observation by multiple observers supplemented by hindcast data or wave measuring devices (wave buoy, wave radar, etc.)                                  |        |
| $H_{1/3}$   | Significant wave height (seas and swell) (m)    | See above                                                                                                                                                       |        |
| $\chi$      | Incident angle of waves ( seas and swell) (rad) | See above                                                                                                                                                       |        |
| $\delta_R$  | Rudder angle (rad)                              | Rudder                                                                                                                                                          |        |
| $\beta$     | Drift angle (rad)                               | GPS                                                                                                                                                             |        |

Table 5: Measured data during sea trials

Prior to the sea trial, the programme of the sea trials and , if available, additional documents listed in table 3 are to be submitted to the verifier in order for the verifier to check the procedure and to attend the sea trial and perform the verifications included in Appendix 1 concerning the sea trial.



The ship speed is to be measured at sea trial for at least three points of which range includes the total propulsion power defined in 5.2 according to the requirements of the IMO Verification Guidelines 4.3.6. This requirement applies individually to each ship, even if the ship is a sistership of a parent vessel.

## 16.2 Estimation of the EEDI reference speed $V_{Ref}$

The adjustment procedure is applicable to the most complex case where sea trials cannot be conducted in EEDI loading condition. It is expected that this will be usually the case for cargo ships like bulk carriers for instance.

The adjustment procedure uses the graphical construction described in Figure 4 that can be described by the following general procedure, applied only to EEDI functioning point (75% of MCR):

Compute for each corrected power value measured during sea trial the ratio  $P_{measured} / P_{tanktestpredicted}$ . These ratios are put on the curve obtained from the model tests in EEDI condition to obtain the curve of the trial results for EEDI condition.

Reference is made to paragraph 3 of Appendix 2 (Figure 3.1) where an example is provided.

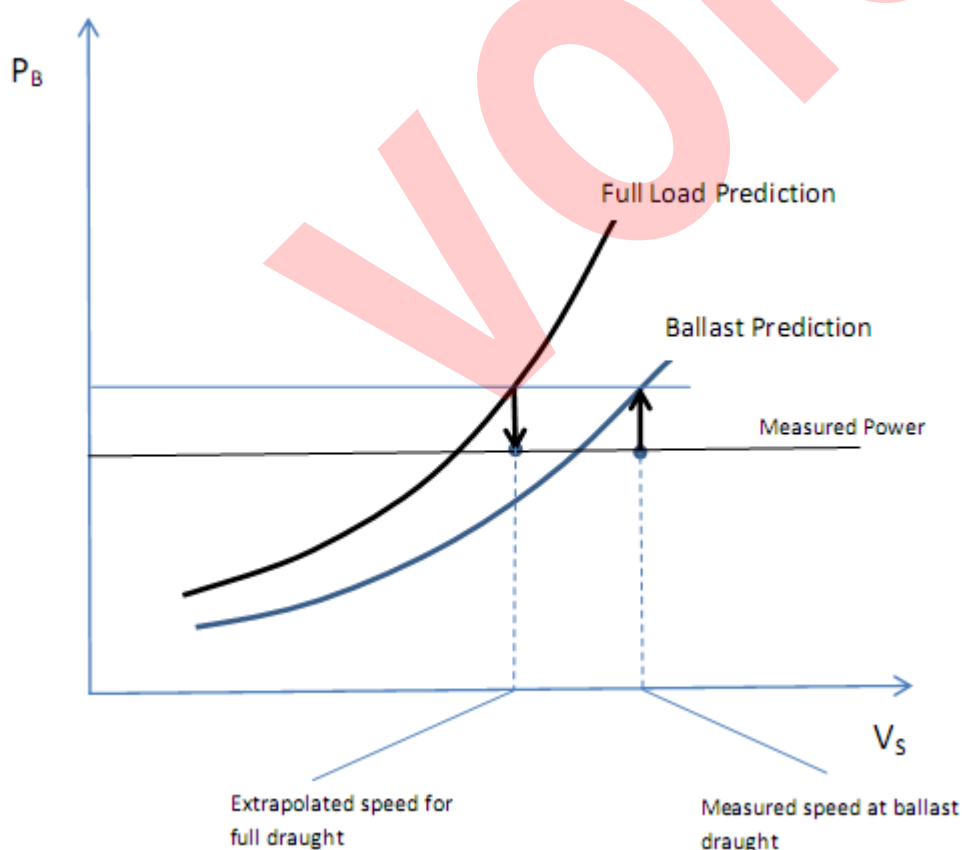


Figure 4: Extrapolation from Measured Values at sea trial draught to EEDI Draught

### **16.3 Revision of EEDI Technical File**

The EEDI Technical File is to be revised, as necessary, by taking into account the results of sea trials. Such revision is to include, as applicable, the adjusted power curve based on the results of sea trial (namely, modified ship speed under the condition as specified in paragraph 2.2 of the IMO Calculation Guidelines), the finally determined deadweight/gross tonnage and the recalculated attained EEDI and required EEDI based on these modifications.

The revised EEDI Technical File is to be submitted to the verifier for the confirmation that the revised attained EEDI is calculated in accordance with regulation 20 of MARPOL Annex VI and the IMO Calculation Guidelines

### **17 VERIFICATION OF THE EEDI IN CASE OF MAJOR CONVERSION**

*Verification of the EEDI in case of major conversion is not taken into account in the first version of this document (see 1.3)*



## APPENDIX 1

### Review and witness points

*Table 4: Review and witness points*

| Ref. | Function                                                                  | Survey method    | Reference document                                                                                                                              | Documentation available to verifier                  | Remarks                                                                                                                                                                                                                                                                                                                                                                            |
|------|---------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01   | EEDI Technical File                                                       | Review           | IMO Verification Guidelines<br>This document                                                                                                    | Documents in table 2                                 |                                                                                                                                                                                                                                                                                                                                                                                    |
| 02   | Limitation of power                                                       | Review           | IMO Calculation Guidelines                                                                                                                      | Verification file of limitation technical means      | Only if means of limitation are fitted                                                                                                                                                                                                                                                                                                                                             |
| 03   | Electric Power Table                                                      | Review           | Appendix 2 to IMO Calculation Guidelines<br>Appendix 2 to IMO Verification Guidelines                                                           | EPT<br>EPT-EEDI form                                 | Only if PAE is significantly different from the values computed using the formula in 2.5.6.1 or 2.5.6.2 of the IMO Calculation Guidelines                                                                                                                                                                                                                                          |
| 04   | Calibration of towing tank test measuring equipment                       | Review & witness | Appendix 3                                                                                                                                      | Calibration reports                                  | Check at random that measuring devices are well identified and that calibration reports are currently valid                                                                                                                                                                                                                                                                        |
| 05   | Model tests – ship model                                                  | Review & witness | Appendix 4                                                                                                                                      | Ship lines plan & offsets table<br>Ship model report | Checks described in Appendix 4.1                                                                                                                                                                                                                                                                                                                                                   |
| 06   | Model tests – propeller model                                             | Review & witness | Appendix 4                                                                                                                                      | Propeller model report                               | Checks described in Appendix 4.2                                                                                                                                                                                                                                                                                                                                                   |
| 07   | Model tests – Resistance test, Propulsion test, Propeller open water test | Review & witness | Appendix 4                                                                                                                                      | Towing tank tests report                             | Checks described in Appendix 4.3<br>Note: propeller open water test is not needed if a stock propeller is used. In this case, the open water characteristics of the stock propeller are to be annexed to the towing tank tests report.                                                                                                                                             |
| 08   | Model-ship extrapolation and correlation                                  | Review           | ITTC 7.5-02-03-01.4 1978 ITTC performance prediction method (rev.02 of 2011 or subsequent revision)<br><br>Appendix 4<br><br>This document 15.7 | Documents in table 2                                 | Check that the ship-model correlation is based on thrust identity with correlation factor according to method 1 ( $C_P - C_N$ ) or method 2 ( $\Delta C_{FC} - \Delta W_C$ )<br><br>Check that the power-speed curves obtained for the EEDI condition and sea trial condition are obtained using the same calculation process with justified values of experience-based parameters |
| 09   | Numerical calculations replacing towing tank tests                        | Review           | ITTC 7.5-03-01-04 (latest revision) or equivalent                                                                                               | Report of calculations                               |                                                                                                                                                                                                                                                                                                                                                                                    |
| 10   | Electrical machinery survey prior to sea trials                           | Witness          | Appendix 2 to IMO Verification Guidelines                                                                                                       |                                                      | Only if $P_{AE}$ is computed from EPT                                                                                                                                                                                                                                                                                                                                              |
| 11   | Programme of sea trials                                                   | Review           | IMO Verification Guidelines                                                                                                                     | Programme of sea trials                              | Check minimum number of measurement points (3)<br>Check the EEDI condition in EPT (if $P_{AE}$ is computed from EPT)                                                                                                                                                                                                                                                               |

| Ref. | Function                                                       | Survey method | Reference document                                      | Documentation available to verifier | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|----------------------------------------------------------------|---------------|---------------------------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12   | Sea trials                                                     | Witness       | ISO 19019:2005 or ITTC 7.5-04-01-01.1 (latest revision) |                                     | <p>Check:</p> <ul style="list-style-type: none"> <li>• Propulsion power, particulars of the engines</li> <li>• Draught and trim</li> <li>• Sea conditions</li> <li>• Ship speed</li> <li>• Shaft power &amp; rpm</li> </ul> <p>Check operation of means of limitations of engines or shaft power (if fitted)</p> <p>Check the power consumption of selected consumers included in sea trials condition EPT (if <math>P_{AE}</math> is computed from EPT)</p> |
| 13   | Sea trials – corrections calculation                           | Review        | ITTC Recommended Procedure 7.5-04-01-01.2 or equivalent | Sea trials report                   | <p>Check that the displacement and trim of the ship in sea trial condition has been obtained with sufficient accuracy</p> <p>Check compliance with ITTC Recommended Procedure 7.5-04-01-01.2 or equivalent</p>                                                                                                                                                                                                                                               |
| 14   | Sea trials – adjustment from trial condition to EEDI condition | Review        | This document 16.2                                      | Power curves after sea trial        | Check that the power curve estimated for EEDI condition is obtained by power adjustment                                                                                                                                                                                                                                                                                                                                                                      |
| 15   | EEDI Technical File – revised after sea trials                 | Review        | IMO Verification Guidelines                             | Revised EEDI Technical File         | Check that the file has been updated according to sea trials results                                                                                                                                                                                                                                                                                                                                                                                         |

## APPENDIX 2

### Sample of document to be submitted to the verifier including additional information for verification

#### Caution

#### Protection of Intellectual Property Rights

This document contains confidential information (defined as additional information) of submitters. Additional information should be treated as strictly confidential by the verifier and failure to do so may lead to penalties. The verifier should note following requirements of IMO Verification Guidelines:

*“4.1.2 The information used in the verification process may contain confidential information of submitters, which requires Intellectual Property Rights (IPR) protection. In the case where the submitter want a non-disclosure agreement with the verifier, the additional information should be provided to the verifier upon mutually agreed terms and conditions.”*

#### Revision list

|             |                   |                                |              |                |                 |
|-------------|-------------------|--------------------------------|--------------|----------------|-----------------|
| B           | 01/05/2014        | Final stage: sections 1 to 16  | XYZ          | YYY            | ZZZ             |
| A           | 01/01/2013        | Design stage: sections 1 to 13 | XXX          | YYY            | ZZZ             |
| <b>REV.</b> | <b>ISSUE DATE</b> | <b>DESCRIPTION</b>             | <b>DRAWN</b> | <b>CHECKED</b> | <b>APPROVED</b> |

#### Content

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## 1 GENERAL

This calculation of the Energy Efficiency Design Index (EEDI) is based on:

- Resolution MEPC.203(62) amendments to include regulations on energy efficiency in MARPOL Annex VI
- Resolution MEPC.212(63) 2012 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships

Calculations are being dealt with according to the Industry Guidelines on calculation and verification of EEDI, 2012 issue.

## 2 DATA

### 2.1 Main parameters

| Parameter                                                   | Value                                                                                                                                                                     | Reference          |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Owner                                                       | OWNER                                                                                                                                                                     |                    |
| Builder                                                     | YARD                                                                                                                                                                      |                    |
| Hull No.                                                    | 12346                                                                                                                                                                     |                    |
| IMO No.                                                     | 94111XX                                                                                                                                                                   |                    |
| Ship's type                                                 | Bulk carrier                                                                                                                                                              |                    |
| Ship classification notations                               | I HULL, MACH, Bulk Carrier CSR<br>BC-A (holds 2 and 4 may be empty)<br>ESP<br>GRAB[20]<br>Unrestricted Navigation<br>AUT-UMS, GREEN PASSPORT,<br>INWATERSURVEY, MON-SHAFT |                    |
| HULL PARTICULARS                                            |                                                                                                                                                                           |                    |
| Length overall                                              | 191.0 m                                                                                                                                                                   |                    |
| Length between perpendiculars                               | 185.0 m                                                                                                                                                                   |                    |
| Breadth, moulded                                            | 32.25 m                                                                                                                                                                   |                    |
| Depth, moulded                                              | 17.9 m                                                                                                                                                                    |                    |
| Summer load line draught, moulded                           | 12.70 m                                                                                                                                                                   |                    |
| Deadweight at summer load line draught                      | 55 000 DWT                                                                                                                                                                |                    |
| Lightweight                                                 | 11 590 tons                                                                                                                                                               |                    |
| Owner's voluntary structural enhancements                   | No                                                                                                                                                                        |                    |
| MAIN ENGINE                                                 |                                                                                                                                                                           |                    |
| Type & manufacturer                                         | BUILDER 6SRT60ME                                                                                                                                                          |                    |
| Specified Maximum Continuous Rating (SMCR)                  | 9 200 kW x 105 rpm                                                                                                                                                        |                    |
| SFC at 75% SMCR                                             | 171 g/kWh                                                                                                                                                                 | See paragraph 10.1 |
| Number of set                                               | 1                                                                                                                                                                         |                    |
| Fuel type                                                   | Diesel/Gas oil                                                                                                                                                            |                    |
| AUXILIARY ENGINES                                           |                                                                                                                                                                           |                    |
| Type & manufacturer                                         | BUILDER 5X28                                                                                                                                                              |                    |
| Specified Maximum Continuous Rating (SMCR)                  | 650 kW x 700 rpm                                                                                                                                                          |                    |
| SFC at 50% SMCR                                             | 205 g/kWh                                                                                                                                                                 | See paragraph 10.2 |
| Number of set                                               | 3                                                                                                                                                                         |                    |
| Fuel type                                                   | Diesel/Gas oil                                                                                                                                                            |                    |
| OVERVIEW OF PROPULSION SYSTEM AND ELECTRICITY SUPPLY SYSTEM |                                                                                                                                                                           | See section 4      |
| SHAFT GENERATORS                                            |                                                                                                                                                                           |                    |
| Type & manufacturer                                         | None                                                                                                                                                                      |                    |
| Rated electrical output power                               |                                                                                                                                                                           |                    |
| Number of set                                               | 0                                                                                                                                                                         |                    |
| SHAFT MOTORS                                                |                                                                                                                                                                           |                    |

| Parameter                                  | Value                   | Reference     |
|--------------------------------------------|-------------------------|---------------|
| Type & manufacturer                        | None                    |               |
| Rated power consumption                    |                         |               |
| Efficiency                                 |                         |               |
| Number of set                              | 0                       |               |
|                                            |                         |               |
| MAIN GENERATORS                            |                         |               |
| Type & manufacturer                        | BUILDER AC120           |               |
| Rated output                               | 605 kWe                 |               |
| Efficiency                                 | 0.93                    |               |
| Number of set                              | 3                       |               |
|                                            |                         |               |
| PROPULSION SHAFT                           |                         |               |
| Propeller diameter                         | 5.9 m                   |               |
| Propeller number of blades                 | 4                       |               |
| Voluntarily limited shaft propulsion power | No                      |               |
| Number of set                              | 1                       |               |
|                                            |                         |               |
| ENERGY SAVING EQUIPMENT                    |                         | See section 9 |
| Description of energy saving equipment     | Propeller boss cap fins |               |
| Power reduction or power output            | None                    |               |

## 2.2 Preliminary verification of attained EEDI

| Parameter                                                                             | Value                                                                                                           | Reference              |
|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------|
| TOWING TANK TEST ORGANIZATION                                                         |                                                                                                                 |                        |
| Identification of organization                                                        | TEST corp.                                                                                                      | See section 6.         |
| ISO Certification or previous experience?                                             | Previous experience                                                                                             |                        |
|                                                                                       |                                                                                                                 |                        |
| TOWING TANK TESTS                                                                     |                                                                                                                 |                        |
| Exemption of towing tank tests                                                        | No                                                                                                              |                        |
| Process and methodology of estimation of the power curves                             |                                                                                                                 | See section 7          |
| Ship model information                                                                |                                                                                                                 | See subparagraph 7.2.1 |
| Propeller model information                                                           |                                                                                                                 | See subparagraph 7.2.2 |
| EEDI & sea trial loading conditions                                                   | EEDI:<br>mean draft: 12.7 m<br>Trim 0<br><br>Sea trial ( ballast ):<br>mean draft: 5.8 m<br>Trim 2.6 m by stern |                        |
| Propeller open water diagram (model, ship)                                            |                                                                                                                 | See paragraph 7.4      |
| Experience based parameters                                                           |                                                                                                                 | See paragraph 7.3      |
| Power curves at full scale                                                            |                                                                                                                 | See section 3          |
| Ship Reference speed                                                                  | 14.25 knots                                                                                                     |                        |
|                                                                                       |                                                                                                                 |                        |
| ELECTRIC POWER TABLE<br>(as necessary, as defined in IMO EEDI Calculation Guidelines) | Significant difference from 2.5.6 of IMO EEDI Calculation Guidelines                                            | See section 5          |
|                                                                                       |                                                                                                                 |                        |
| CALCULATION OF ATTAINED EEDI                                                          | 5.06                                                                                                            | See section 11         |
|                                                                                       |                                                                                                                 |                        |
| CALCULATION OF REQUIRED EEDI                                                          | 5.27                                                                                                            | See section 12         |
|                                                                                       |                                                                                                                 |                        |
| CALCULATION OF ATTAINED EEDI <sub>weather</sub>                                       | Not calculated                                                                                                  | See section 13         |

## 2.3 Final verification of attained EEDI

| Parameter                         | Value       | Reference      |
|-----------------------------------|-------------|----------------|
| SEA TRIAL LOADING CONDITION       |             |                |
| POWER CURVES                      |             | See section 3  |
| Sea trial report with corrections |             | See section 15 |
| Ship Reference speed              | 14.65 knots |                |
| FINAL DEADWEIGHT                  |             | See section 14 |
| Displacement                      | 66 171 tons |                |
| Lightweight                       | 11 621 tons |                |
| Deadweight                        | 54 550 DWT  |                |
| FINAL ATTAINED EEDI               | 4.96        | See section 16 |

## 3 POWER CURVES

The power curves estimated at the design stage and modified after the sea trials are given in Figure 3.1.

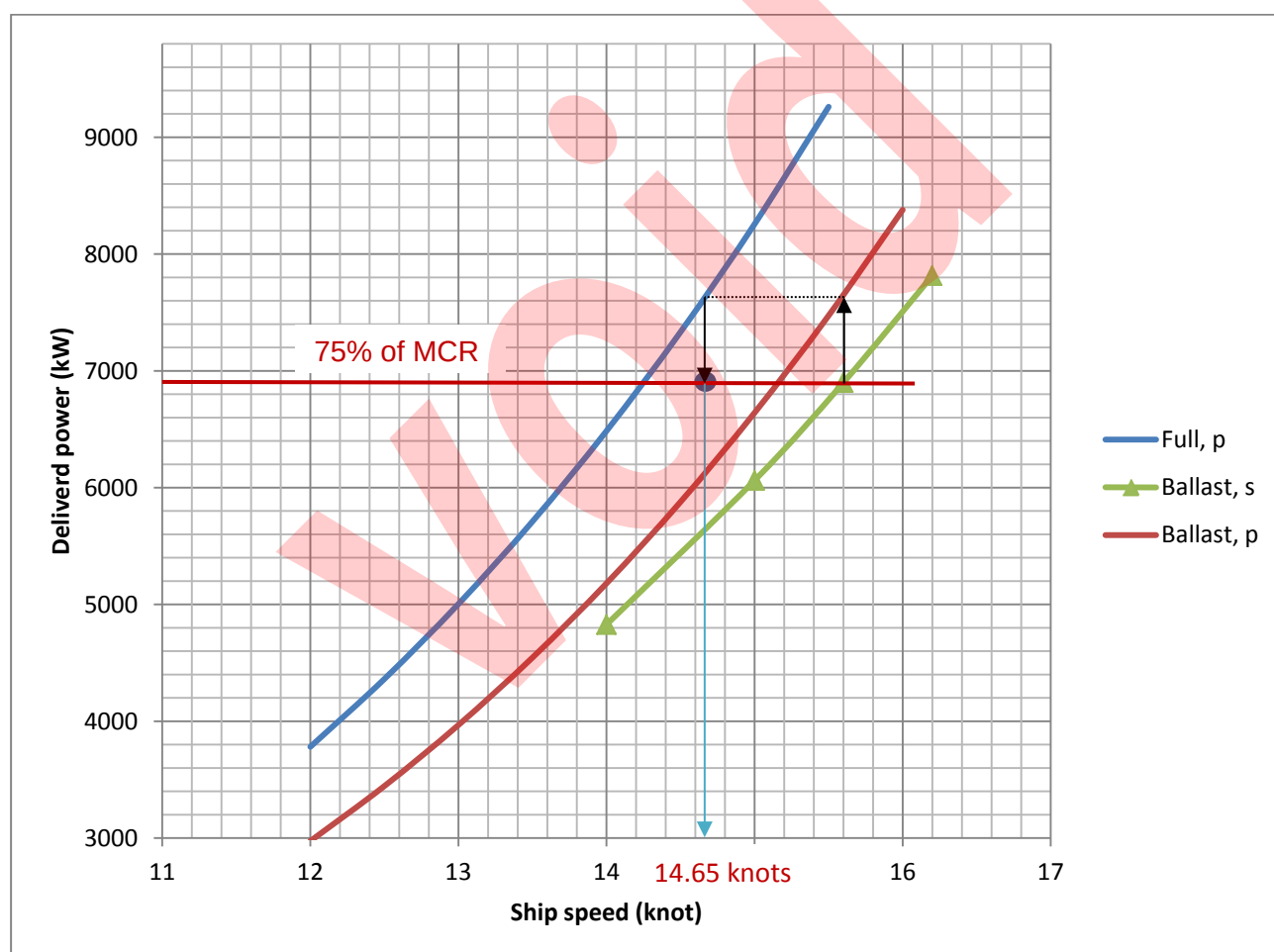


Figure 3.1: Power curves

## 4 OVERVIEW OF PROPULSION SYSTEM AND ELECTRIC POWER SYSTEM

Figure 4.1 shows the connections within the propulsion and electric power supply systems.

The characteristics of the main engines, auxiliary engines, electrical generators and propulsion electrical motors are given in table 2.1.

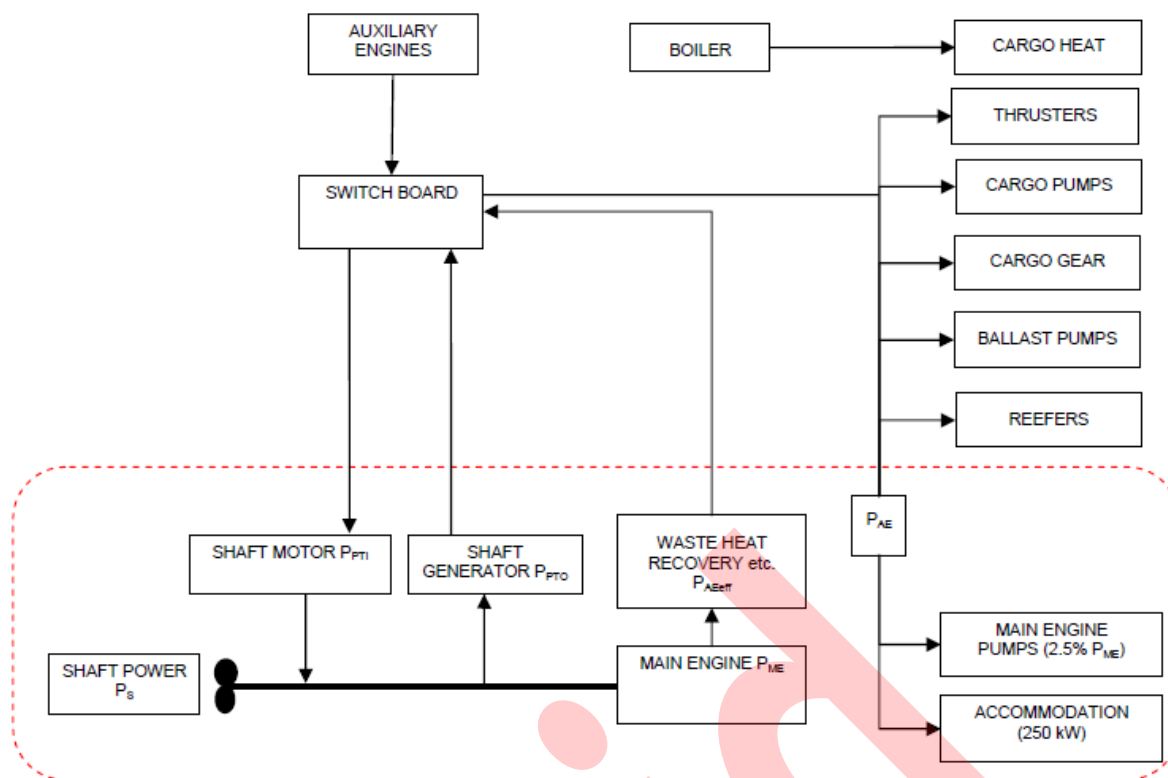


Figure 4.1 scheme of the propulsion and power generation systems

## 5 ELECTRIC POWER TABLE

The electric power for the calculation of EEDI is provided in table 5.1.

| Id | Group | Description                      | Mech. Power "Pm" | El. Motor output | Efficien. "e" | Rated el. Power "Pr" | load factor "kl" | duty factor "kd" | time factor "kt" | use factor "ku" | Necessary power "Pload" |
|----|-------|----------------------------------|------------------|------------------|---------------|----------------------|------------------|------------------|------------------|-----------------|-------------------------|
| 1  | A     | STEERING GEAR                    | N.A.             | N.A.             | N.A.          | 45,0                 | 0,9              | 1                | 0,3              | 0,27            | 12,2                    |
| 2  | A     | HULL CATHODIC PROTECTION         | N.A.             | N.A.             | N.A.          | 10                   | 1                | 1                | 1                | 1,00            | 10,0                    |
| 3  | A     | CRANE                            | N.A.             | N.A.             | N.A.          | 10,00                | 0,2              | 1                | 1                | 0,20            | 2,0                     |
| 4  | A     | COMPASS                          | N.A.             | N.A.             | N.A.          | 0,5                  | 1                | 1                | 1                | 1,00            | 0,5                     |
| 5  | A     | RADAR NO.1                       | N.A.             | N.A.             | N.A.          | 1,3                  | 1                | 0,5              | 1                | 0,50            | 0,7                     |
| 6  | A     | RADAR NO.2                       | N.A.             | N.A.             | N.A.          | 1,3                  | 1                | 0,5              | 1                | 0,50            | 0,7                     |
| 7  | A     | NAVIGATION EQUIPMENT             | N.A.             | N.A.             | N.A.          | 5,0                  | 1                | 1                | 1                | 1,00            | 5,0                     |
| 8  | A     | INTERNAL COMM. EQUIPMENT         | N.A.             | N.A.             | N.A.          | 2,5                  | 1                | 1                | 0,1              | 0,10            | 0,2                     |
| 9  | A     | RADIO EQUIPMENT                  | N.A.             | N.A.             | N.A.          | 3,5                  | 1                | 1                | 0,1              | 0,10            | 0,4                     |
| 10 | A     | MOORING EQ.                      | N.A.             | N.A.             | N.A.          | 7,0                  | 1                | 1                | 0,1              | 0,10            | 0,7                     |
| 11 | B     | MAIN COOLING SEA WATER PUMP NO.1 | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 12 | B     | MAIN COOLING SEA WATER PUMP NO.2 | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 13 | B     | MAIN COOLING SEA WATER PUMP NO.3 | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 14 | B     | LT COOLING FW PUMP NO.1          | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 15 | B     | LT COOLING FW PUMP NO.2          | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 16 | B     | LT COOLING FW PUMP NO.3          | 28,0             | 30               | 0,925         | 30,3                 | 0,9              | 0,66             | 1                | 0,59            | 18,0                    |
| 17 | B     | M/E COOLING WATER PUMP NO.1      | 13,0             | 15               | 0,9           | 14,4                 | 1                | 0,5              | 1                | 0,50            | 7,2                     |
| 18 | B     | M/E COOLING WATER PUMP NO.2      | 13,0             | 15               | 0,9           | 14,4                 | 1                | 0,5              | 1                | 0,50            | 7,2                     |
| 19 | C     | MAIN LUB. OIL PUMP NO.1          | 55,0             | 90               | 0,94          | 58,5                 | 0,9              | 0,5              | 1                | 0,45            | 26,3                    |



| Id | Group | Description                         | Mech. Power "Pm" | El. Motor output | Efficien. "e" | Rated el. Power "Pr" | load factor "kl" | duty factor "kd" | time factor "kt" | use factor "ku" | Necessary power "Pload" |
|----|-------|-------------------------------------|------------------|------------------|---------------|----------------------|------------------|------------------|------------------|-----------------|-------------------------|
| 20 | C     | MAIN LUB. OIL PUMP NO.2             | 55,0             | 90               | 0,94          | 58,5                 | 0,9              | 0,5              | 1                | 0,45            | 26,3                    |
| 21 | C     | H.F.O. TRANSFER PUMP                | 6,0              | 7,5              | 0,88          | 6,8                  | 1                | 1                | 0,1              | 0,10            | 0,7                     |
| 22 | C     | D.O. TRANSFER PUMP                  | 6,0              | 7,5              | 0,88          | 6,8                  | 1                | 1                | 0,1              | 0,10            | 0,7                     |
| 23 | C     | L.O. TRANSFER PUMP                  | 1,4              | 2,5              | 0,8           | 1,8                  | 1                | 1                | 0,1              | 0,10            | 0,2                     |
| 24 | C     | TECHNICAL FRESH WATER PUMP NO.1     | 2,5              | 3,5              | 0,85          | 2,9                  | 1                | 0,5              | 0,1              | 0,05            | 0,1                     |
| 25 | C     | TECHNICAL FRESH WATER PUMP NO.2     | 2,5              | 3,5              | 0,85          | 2,9                  | 1                | 0,5              | 0,1              | 0,05            | 0,1                     |
| 26 | C     | E/R SUPPLY FAN NO.1                 | 14,0             | 20               | 0,9           | 15,5                 | 0,9              | 1                | 1                | 0,90            | 14,0                    |
| 27 | C     | E/R SUPPLY FAN NO.2                 | 14,0             | 20               | 0,9           | 15,5                 | 0,9              | 1                | 1                | 0,90            | 14,0                    |
| 28 | C     | E/R SUPPLY FAN NO.3                 | 14,0             | 20               | 0,9           | 15,5                 | 0,9              | 1                | 1                | 0,90            | 14,0                    |
| 29 | C     | E/R SUPPLY FAN NO.4                 | 14,0             | 20               | 0,9           | 15,5                 | 0,9              | 1                | 1                | 0,90            | 14,0                    |
| 30 | C     | PURIFIER ROOM EXH. VENTILATOR       | 2,5              | 3                | 0,82          | 3,0                  | 0,9              | 1                | 1                | 0,90            | 2,7                     |
| 31 | C     | PUMP HFO SUPPLY UNIT NO.1           | 2,1              | 3                | 0,8           | 2,6                  | 0,9              | 0,5              | 1                | 0,45            | 1,2                     |
| 32 | C     | PUMP HFO SUPPLY UNIT NO.2           | 2,1              | 3                | 0,8           | 2,6                  | 0,9              | 0,5              | 1                | 0,45            | 1,2                     |
| 33 | C     | CIRC. PUMP FOR HFO SUPPLY UNIT NO.1 | 2,8              | 3,5              | 0,84          | 3,3                  | 0,9              | 0,5              | 1                | 0,45            | 1,5                     |
| 34 | C     | CIRC. PUMP FOR HFO SUPPLY UNIT NO.2 | 2,8              | 3,5              | 0,84          | 3,3                  | 0,9              | 0,5              | 1                | 0,45            | 1,5                     |
| 35 | C     | H.F.O. SEPARATOR NO.1               | N.A.             | N.A.             | N.A.          | 6,5                  | 0,9              | 0,5              | 0,9              | 0,41            | 2,6                     |
| 36 | C     | H.F.O. SEPARATOR NO.2               | N.A.             | N.A.             | N.A.          | 6,5                  | 0,9              | 0,5              | 0,9              | 0,41            | 2,6                     |
| 37 | C     | MAIN AIR COMPRESSOR NO.1            | N.A.             | N.A.             | N.A.          | 43,0                 | 1                | 0,5              | 0,1              | 0,05            | 2,2                     |
| 38 | C     | MAIN AIR COMPRESSOR NO.2            | N.A.             | N.A.             | N.A.          | 43,0                 | 1                | 0,5              | 0,1              | 0,05            | 2,2                     |
| 39 | C     | SERVICE AIR COMPRESSOR              | N.A.             | N.A.             | N.A.          | 22,0                 | 1                | 1                | 0,1              | 0,10            | 2,2                     |
| 40 | C     | VENT. AIR SUPPLY                    | N.A.             | N.A.             | N.A.          | 1,0                  | 1                | 1                | 0,5              | 0,50            | 0,1                     |
| 41 | C     | BILGE WATER SEPARATOR               | N.A.             | N.A.             | N.A.          | 1,5                  | 1                | 1                | 0,1              | 0,10            | 0,2                     |
| 42 | C     | M/E L.O. SEPARATOR                  | N.A.             | N.A.             | N.A.          | 6,5                  | 0,9              | 1                | 0,2              | 0,18            | 1,2                     |
| 43 | C     | G/E L.O. SEPARATOR                  | N.A.             | N.A.             | N.A.          | 6,5                  | 0,9              | 1                | 0,2              | 0,18            | 1,2                     |
| 44 | D     | HYDROPHORE PUMP NO.1                | 2,8              | 4                | 0,84          | 3,3                  | 1                | 0,5              | 0,1              | 0,05            | 0,2                     |
| 45 | D     | HYDROPHORE PUMP NO.2                | 2,8              | 4                | 0,84          | 3,3                  | 1                | 0,5              | 0,1              | 0,05            | 0,2                     |
| 46 | D     | HOT WATER CIRCULATING PUMP NO.1     | 0,5              | 1,0              | 0,8           | 0,8                  | 1                | 0,5              | 0,2              | 0,10            | 0,1                     |
| 47 | D     | HOT WATER CIRCULATING PUMP NO.2     | 0,5              | 1,0              | 0,8           | 0,8                  | 1                | 0,5              | 0,2              | 0,10            | 0,1                     |
| 48 | E     | E/R WORKSHOP WELDING SPACE EXH.     | 0,5              | 0,8              | 0,8           | 0,6                  | 0,9              | 1                | 1                | 0,90            | 0,6                     |
| 49 | F     | ECR COOLER UNIT                     | N.A.             | N.A.             | N.A.          | 4,2                  | 1                | 1                | 0,5              | 0,50            | 2,1                     |
| 50 | F     | FAN FOR AIR CONDITIONING PLANT      | N.A.             | N.A.             | N.A.          | 8,0                  | 0,9              | 1                | 0,5              | 0,45            | 3,6                     |
| 51 | F     | COMP. AIR CONDITIONING PLANT NO.1   | N.A.             | N.A.             | N.A.          | 10,0                 | 0,9              | 1                | 0,5              | 0,45            | 4,5                     |
| 52 | F     | COMP. AIR CONDITIONING PLANT NO.2   | N.A.             | N.A.             | N.A.          | 10,0                 | 0,9              | 1                | 0,5              | 0,45            | 4,5                     |
| 53 | F     | COMP. AIR CONDITIONING PLANT NO.3   | N.A.             | N.A.             | N.A.          | 10,0                 | 0,9              | 1                | 0,5              | 0,45            | 4,5                     |
| 54 | F     | COMP. AIR CONDITIONING PLANT NO.4   | N.A.             | N.A.             | N.A.          | 10,0                 | 0,9              | 1                | 0,5              | 0,45            | 4,5                     |
| 55 | G     | FAN FOR GALLEY AIR COND. PLANT      | N.A.             | N.A.             | N.A.          | 1,5                  | 0,9              | 1                | 0,5              | 0,45            | 0,7                     |
| 56 | G     | COMP. FOR GALLEY AIR COND. PLANT    | N.A.             | N.A.             | N.A.          | 3,5                  | 0,9              | 1                | 0,5              | 0,45            | 1,6                     |
| 57 | G     | REF. COMPRESSOR NO.1                | N.A.             | N.A.             | N.A.          | 4,0                  | 1                | 0,5              | 0,1              | 0,05            | 0,2                     |
| 58 | G     | REF. COMPRESSOR NO.2                | N.A.             | N.A.             | N.A.          | 4,0                  | 1                | 0,5              | 0,1              | 0,05            | 0,2                     |
| 59 | G     | GALLEY EQUIPMENT                    | N.A.             | N.A.             | N.A.          | 80,0                 | 0,5              | 1                | 0,1              | 0,05            | 4,0                     |
| 60 | H     | VAC. COLLECTION SYSTEM              | 2,4              | 3,0              | 0,8           | 3,0                  | 1                | 1                | 1                | 1,00            | 3,0                     |
| 61 | H     | GALLEY EXH.                         | 1,2              | 1,5              | 0,8           | 1,5                  | 1                | 1                | 1                | 1,00            | 1,5                     |
| 62 | H     | LAUNDRY EXH.                        | 0,1              | 0,15             | 0,8           | 0,1                  | 1                | 1                | 1                | 1,00            | 0,1                     |
| 63 | H     | SEWAGE TREATMENT                    | N.A.             | N.A.             | N.A.          | 4,5                  | 1                | 1                | 0,1              | 0,10            | 0,5                     |

| Id                                                                                           | Group | Description            | Mech. Power "Pm" | El. Motor output | Efficien. "e" | Rated el. Power "Pr" | load factor "kl" | duty factor "kd" | time factor "kt"   | use factor "ku" | Necessary power "Pload" |
|----------------------------------------------------------------------------------------------|-------|------------------------|------------------|------------------|---------------|----------------------|------------------|------------------|--------------------|-----------------|-------------------------|
| 64                                                                                           | H     | SEWAGE DISCHARGE       | 3                | 7,5              | 0,88          | 3,4                  | 0,9              | 1                | 0,1                | 0,09            | 0,3                     |
| 65                                                                                           | I     | ACCOMMODATION LIGHTING | N.A.             | N.A.             | N.A.          | 16,0                 | 1                | 1                | 0,5                | 0,5             | 8,0                     |
| 66                                                                                           | I     | E/R LIGHTING           | N.A.             | N.A.             | N.A.          | 18,0                 | 1                | 1                | 1                  | 1,00            | 18,0                    |
| 67                                                                                           | I     | NAVIGATION LIGHTING    | N.A.             | N.A.             | N.A.          | 0,9                  | 1                | 0,5              | 1                  | 0,50            | 0,4                     |
| 68                                                                                           | I     | BACK. NAV. LIGHTING    | N.A.             | N.A.             | N.A.          | 0,9                  | 1                | 0,5              | 1                  | 0,50            | 0,4                     |
|                                                                                              |       |                        |                  |                  |               |                      |                  |                  | <b>TOTAL POWER</b> |                 | <b>354,0</b>            |
| <b>P<sub>AE</sub> = Total Power / (average efficiency of generators) = 354/0.93 = 381 kW</b> |       |                        |                  |                  |               |                      |                  |                  |                    |                 |                         |

**Table 5.1: Electric power table for calculation of PAE**

## 6 TOWING TANK TEST ORGANIZATION QUALITY SYSTEM

Towing tank tests will be performed in TEST corp.

The quality control system of the towing tank test organization TEST corp. has been documented previously (see report 100 for the ship hull No. 12345) and the quality manual and calibration records are available to the verifier.

The measuring equipment has not been modified since the issue of report 100 and is listed in table 6.1.

|                       | Manufacturer | Model | Series | Lab. Id. | status                   |
|-----------------------|--------------|-------|--------|----------|--------------------------|
| Propeller dynamometer | B&N          | 6001  | 300    | 125-2    | Calibrated<br>01/01/2011 |
| ...                   |              |       |        |          |                          |

**Table 6.1: List of measuring equipment**

## 7 ESTIMATION PROCESS OF POWER CURVES AT DESIGN STAGE

### 7.1 Test procedure

The tests and their analysis are conducted by TEST corp. applying their standard correlation method (document is given in annex 1).

The method is based on thrust identity and references ITTC Recommended Procedure 7.5 - 02 - 03 -1.4 ITTC 1978 Trial Prediction Method (in its latest reviewed version of 2011), with prediction of the full scale rpm and delivered power by use of the  $C_P - C_N$  correction factors.

The results are based on a Resistance Test, a Propulsion Test and use the Open Water Characteristics of the model propeller used during the tests and the Propeller Open Water Characteristics of the final propeller given in 7.4.

Results of the resistance tests and propulsion tests of the ship model are given in the report of TEST corp. given in annex 2.

### 7.2 Speed prediction

The ship delivered power  $P_D$  and rate of revolutions  $n_S$  are determined from the following equations:

$$\begin{aligned} P_D &= C_P \cdot P_{DS} \\ n_T &= C_N \cdot n_S \end{aligned}$$

Where  $C_N$  and  $C_P$  are experience-based factors and  $P_{DS}$  (resp.  $n_S$ ) are the delivered power (resp. rpm) obtained from the analysis of the towing tank tests.

The ship total resistance coefficient  $C_{TS}$  is given by:

$$C_{TS} = \frac{S_S + S_{BK}}{S_S} \cdot [(1 + k) \cdot C_{FS} + \Delta C_F] + C_R + C_{AAS} + C_{AppS}$$

Where:

$S_S$ : ship hull wetted surface, here 9886 m<sup>2</sup>

$S_{BK}$ : wetted surface of bilge keels

$k$ : form factor. Here  $1+k = 1.38$  over the speed range, determined according to ITTC standard procedure 7.5-02-02-01

$C_{FS}$ : ship frictional resistance coefficient (computed according to ITTC 1957 formula)

$\Delta C_F$ : roughness allowance, computed according to Bowden-Davison formula. Here  $\Delta C_F = 0.000339$

$C_R$ : residual resistance coefficient

$C_{AAS}$ : air resistance coefficient

$C_{AppS}$ : ship appendages (propeller boss cap fins) resistance coefficient, computed as provided in annex 2.

The air resistance coefficient is computed according to the following formula:

$$C_{AAS} = C_{DA} \cdot \frac{\rho_A \cdot A_{VS}}{\rho_S \cdot S_S}$$

Where:

$C_{DA}$  is the air drag coefficient, here 0.8

$\rho_A$  and  $\rho_S$  are the air density and water density, respectively

$A_{VS}$  is the projected wind area, here 820 m<sup>2</sup>

$C_{AAS} = 7.9 \cdot 10^{-5}$

The delivered power  $P_D$  results of the towing tank tests are summarized in table 7.1 for the EEDI condition (scantling draft) and in table 7.2 for the sea trial condition (light ballast draft).

|                                                           |                             |                             |                              |                         |                            |
|-----------------------------------------------------------|-----------------------------|-----------------------------|------------------------------|-------------------------|----------------------------|
| Model reference: SX100 - model scale: 40                  |                             |                             |                              |                         |                            |
| Loading condition: EEDI loading condition (12.70 m draft) |                             |                             |                              |                         |                            |
| Resistance test: R001                                     |                             | Propulsion test: P001       |                              | Model propeller: Prop01 |                            |
| Ship speed V (knot)                                       | Wake factor $w_{TM-W_{TS}}$ | Propeller thrust $T_S$ (kN) | Propeller torque $Q_S$ (kNm) | rpm on ship $n_S$       | Delivered Power $P_D$ (kW) |
| 12                                                        | 0.098                       | 522                         | 467                          | 78                      | 3781                       |
| 12.5                                                      | 0.093                       | 578                         | 514                          | 82                      | 4362                       |
| 13                                                        | 0.089                       | 638                         | 563                          | 86                      | 5004                       |
| 13.5                                                      | 0.081                       | 701                         | 615                          | 90                      | 5710                       |
| 14                                                        | 0.079                       | 768                         | 669                          | 93                      | 6486                       |
| 14.5                                                      | 0.086                       | 838                         | 727                          | 97                      | 7333                       |
| 15                                                        | 0.091                       | 912                         | 786                          | 101                     | 8257                       |
| 15.5                                                      | 0.099                       | 990                         | 849                          | 105                     | 9261                       |
| Experience-based factor $C_P$ : 1.01                      |                             |                             |                              |                         |                            |
| Experience based factor $C_N$ : 1.02                      |                             |                             |                              |                         |                            |

**Table 7.1: results of trial prediction in EEDI condition**

|                                                       |                                |                                |                                 |                            |                               |
|-------------------------------------------------------|--------------------------------|--------------------------------|---------------------------------|----------------------------|-------------------------------|
| Model reference: SX100 - model scale: 40              |                                |                                |                                 |                            |                               |
| Loading condition: Sea trial condition (5.80 m draft) |                                |                                |                                 |                            |                               |
| Resistance test:<br>R002                              |                                | Propulsion test: POO2          |                                 | Model propeller:<br>Prop01 |                               |
| Ship speed V<br>(knot)                                | Wake factor<br>$W_{TM}-W_{TS}$ | Propeller thrust $T_S$<br>(kN) | Propeller torque $Q_S$<br>(kNm) | rpm on ship $n_S$          | Delivered Power $P_D$<br>(kW) |
| 12                                                    | 0,079                          | 406                            | 379                             | 72                         | 2974                          |
| 12,5                                                  | 0,081                          | 451                            | 418                             | 76                         | 3445                          |
| 13                                                    | 0,083                          | 500                            | 459                             | 79                         | 3968                          |
| 13,5                                                  | 0,085                          | 551                            | 503                             | 83                         | 4545                          |
| 14                                                    | 0,087                          | 606                            | 549                             | 87                         | 5181                          |
| 14,5                                                  | 0,088                          | 664                            | 597                             | 90                         | 5878                          |
| 15                                                    | 0,091                          | 725                            | 648                             | 94                         | 6641                          |
| 15,5                                                  | 0,089                          | 790                            | 701                             | 98                         | 7474                          |
| Experience-based factor $C_P$ : 1.05                  |                                |                                |                                 |                            |                               |
| Experience based factor $C_N$ : 1.03                  |                                |                                |                                 |                            |                               |

**Table 7.2: results of trial prediction in sea trial condition**

The predicted results are represented on the speed curves given in Figure 3.1. The EEDI condition results are indexed (Full, p), the sea trial condition results (Ballast, p).

### 7.3 Ship and propeller models

The ship model is at scale  $\lambda = 40$ . The characteristics are given in table 7.3.

|                                                    |                                             |
|----------------------------------------------------|---------------------------------------------|
| Identification (model number or similar)           | SX 100                                      |
| Material of construction                           | Wood                                        |
| Principal dimensions                               |                                             |
| Length between perpendiculars ( $L_{PP}$ )         | 4.625 m                                     |
| Length of waterline ( $L_{WL}$ )                   | 4.700 m                                     |
| Breadth ( $B$ )                                    | 0.806 m                                     |
| Draught ( $T$ )                                    | 0.317 m                                     |
| Design displacement ( $\Delta$ ) (kg, fresh water) | 1008.7 kg                                   |
| Wetted surface area                                | 6.25 m <sup>2</sup>                         |
| Details of turbulence stimulation                  | Sand strips                                 |
| Details of appendages                              | rudder                                      |
| Tolerances of manufacture                          | +/- 2.5 mm on length<br>+/- 1 mm on breadth |

**Table 7.3: characteristics of the ship model**

The propeller model used during the tests is a stock model with the following characteristics:

|                                          |                                                                                                                                                                   |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification (model number or similar) | Prop01                                                                                                                                                            |
| Materials of construction                | aluminium                                                                                                                                                         |
| Blade number                             | 4                                                                                                                                                                 |
| Principal dimensions                     |                                                                                                                                                                   |
| Diameter                                 | 147.5 mm                                                                                                                                                          |
| Pitch-Diameter Ratio ( $P/D$ )           | 0.68                                                                                                                                                              |
| Expanded blade Area Ratio ( $A_E/A_0$ )  | 0.60                                                                                                                                                              |
| Thickness Ratio ( $t/D$ )                | 0.036                                                                                                                                                             |
| Hub/Boss Diameter ( $d_h$ )              | 25 mm                                                                                                                                                             |
| Tolerances of manufacture                | Diameter (D): $\pm 0.10$ mm<br>Thickness (t): $\pm 0.10$ mm<br>Blade width (c): $\pm 0.20$ mm<br>Mean pitch at each radius (P/D):<br>$\pm 0.5\%$ of design value. |

**Table 7.4: characteristics of the stock propeller used during the tests**

## 7.4 Open water characteristics of propeller

The open water characteristics of the stock model propeller are given in annex 2. The open water characteristics of the ship propeller are given in Figure 7.1.

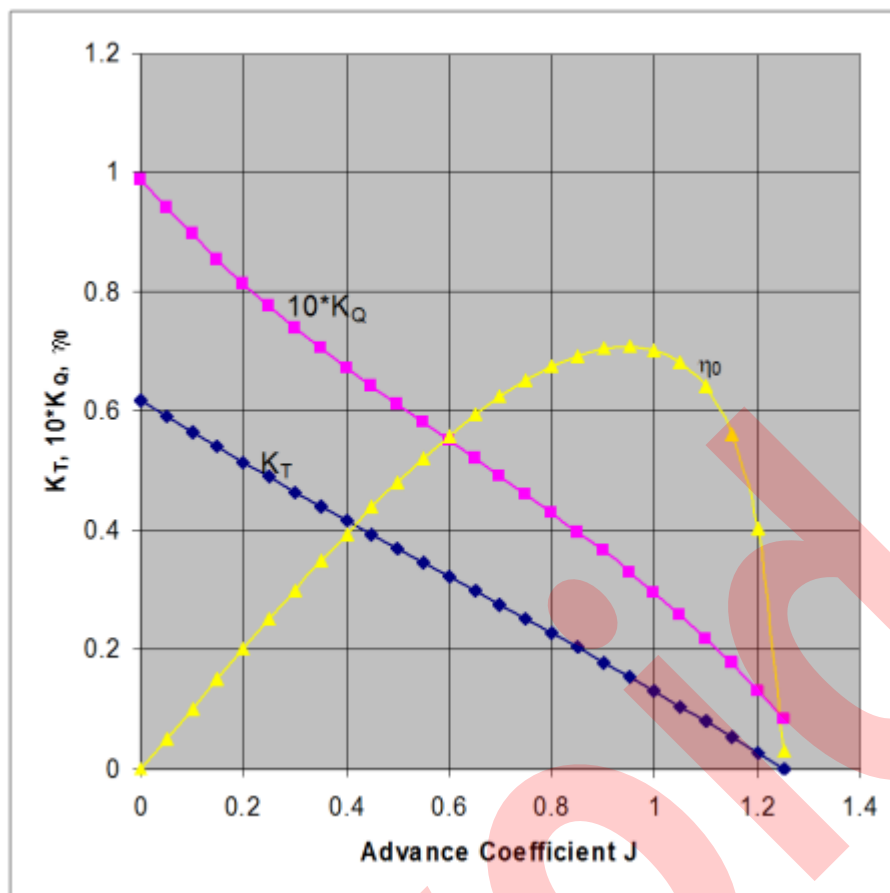


Figure 7.1: open water characteristics of ship propeller

## 8 LINES AND OFFSETS OF THE SHIP

The ships lines and offsets table are given in Annex 3.

## 9 DESCRIPTION OF ENERGY SAVING EQUIPMENT

### 9.1 Energy saving equipment of which effects are expressed as $P_{AEff(i)}$ and/or $P_{eff(i)}$ in the EEDI calculation formula

None here.

### 9.2 Other energy saving equipment

The propeller boss cap fins are described in annex 4.

## 10 JUSTIFICATION OF SFC (DOCUMENTS ATTACHED TO NO<sub>x</sub> TECHNICAL FILE OF THE PARENT ENGINE)

### 10.1 Main engine

The shop test report for the parent main engine is provided in annex 5.1. The SFOC has been corrected to ISO conditions.

### 10.2 Auxiliary engine

The technical file of the EIAPP certificate of the auxiliary engines is provided in annex 5.2. The SFOC has been corrected to ISO conditions.

## 11 CALCULATION OF ATTAINED EEDI AT DESIGN STAGE

### 11.1 Input parameters and definitions

The EEDI quantities and intermediate calculations are listed in table 11.1:

| EEDI quantity | Value       | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $C_{FME}$     | 3.206       | Marine Diesel oil is used for shop test of the main engine                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| $P_{ME}$      | 6 900 kW    | No shaft generator installed ( $P_{PTO} = 0$ )<br>MCR is 9200 kW $P_{ME} = 0.75 \times 9200 = 6\,900$ kW                                                                                                                                                                                                                                                                                                                                                                                                                              |
| $SFC_{ME}$    | 171 g/kWh   | According to parent engine shop test report in ISO conditions (see 10.1)                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| $CF_{AE}$     | 3.206       | Marine diesel oil is used for shop test of the auxiliary engine                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| $P_{PTI}$     | 0           | No shaft motor installed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| $P_{AE}$      | 381 kW      | MCR of the engine is 9200 kW, less than 10000kW<br>$P_{AE} = 0.05 \cdot \left( \sum_{i=1}^{n_{ME}} MCR_{MEi} + \frac{\sum_{i=1}^{n_{PTI}} P_{PTI(i)}}{0.75} \right)$ $P_{AE} = 0.05 \times 9200 = 460$ kW<br>According to electric power table included in table 5.1, $\sum P_{load(i)} = 354$ kW<br>The weighted average efficiency of generators = 0.93 (KWelec/kWmech)<br>$P_{AE} = \sum P_{load(i)} / 0.93 = 381$ kW<br>The difference (460 – 381) kW is expected to vary EEDI by slightly more than 1%, so 381 kW is considered. |
| $SFC_{AE}$    | 205 g/kWh   | According to technical file of EIAPP certificate in ISO conditions (see 10.2)                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| $P_{eff}$     | 0           | No mechanical energy efficient devices<br>The propeller boss cap fins act by reducing ship resistance                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| $P_{AEff}$    | 0           | No auxiliary power reduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| $f_{eff}$     |             | Not relevant here (see above)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| $f_i$         | 1.0         | The ship is a bulk carrier without ice notations. $f_i = 1.0$                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| $f_i$         | 1.017       | No ice notation $f_{iICE} = 1.0$<br>No voluntary structural enhancement for this ship $f_{iVSE} = 1.0$<br>The ship has the notation Bulk carrier CSR:<br>$f_{iCSR} = 1 + 0.08 \cdot LWT_{CSR} / DWT_{CSR} = 1 + 0.08 \cdot 11590 / 55000 = 1.017$<br>$f_i = f_{iICE} \times f_{iVSE} \times f_{iCSR} = 1.017$                                                                                                                                                                                                                         |
| $f_w$         | 1.0         | For attained EEDI calculation under regulation 20 and 21 of MARPOL Annex VI, $f_w$ is 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| $f_c$         | 1.0         | The ship is a bulk carrier $f_c = 1.0$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Capacity      | 55000       | For a bulk carrier, Capacity is deadweight = 55 000 tons                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| $V_{ref}$     | 14.25 knots | At design stage, reference speed is obtained from the towing tank test report and delivered power in scantling draft (EEDI) condition is given in table 7.1<br>In table 7.1 $P_D = 1.0 \times P_{ME} = 6900$ kW<br>The reference speed is read on the speed curve corresponding to table 7.1 at intersection between curve Full, $p$ and 6900 kW<br>$V_{ref} = 14.25$ knots                                                                                                                                                           |

Table 11.1: Parameters in attained EEDI calculation

### 11.2 Result

For this vessel, Attained EEDI is:

$$\frac{(\prod_{j=1}^n f_j) \cdot (\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}) + P_{AE} \cdot C_{FAE} \cdot SFC_{AE} + \{(\prod_{j=1}^n f_j) \cdot \sum_{i=1}^{n_{PTI}} P_{PTI(i)} - \sum_{i=1}^{n_{eff}} f_{eff(i)} \cdot P_{AEff(i)}\} \cdot C_{FAE} \cdot SFC_{AE} - \sum_{i=1}^{n_{eff}} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}}{f_i \cdot f_c \cdot Capacity \cdot f_w \cdot V_{ref}}$$

$$\text{Attained EEDI} = (6900 \times 3.206 \times 171 + 381 \times 3.206 \times 205) / (1.017 \times 55000 \times 14.25) = 5.06 \text{ g/t.nm}$$

## 12 REQUIRED EEDI

According to MARPOL Annex VI, Chapter 4, Regulation 21, the required EEDI is:

$(1-x/100) \times \text{reference line value}$

The reference line value =  $a \cdot b^c$  where  $a$ ,  $b$ ,  $c$  are given for a bulk carrier as:

$$a = 961.79 \quad b = \text{deadweight of the ship} \quad c = 0.477$$

So reference line value = 5.27 g/t.nm  
 In Phase 0 (between 1 Jan 2013 and 31 Dec 2014) above 20000 DWT,  $x = 0$   
 So Required EEDI = 5.27 g/t.nm

Figure 12.1 provides the relative position of attained EEDI with reference to required value.

As a conclusion, for this vessel:

- attained EEDI = 5.06 g/t.nm
- required EEDI = 5.27 g/t.nm
- **Regulation criteria is satisfied with 4% margin**

R

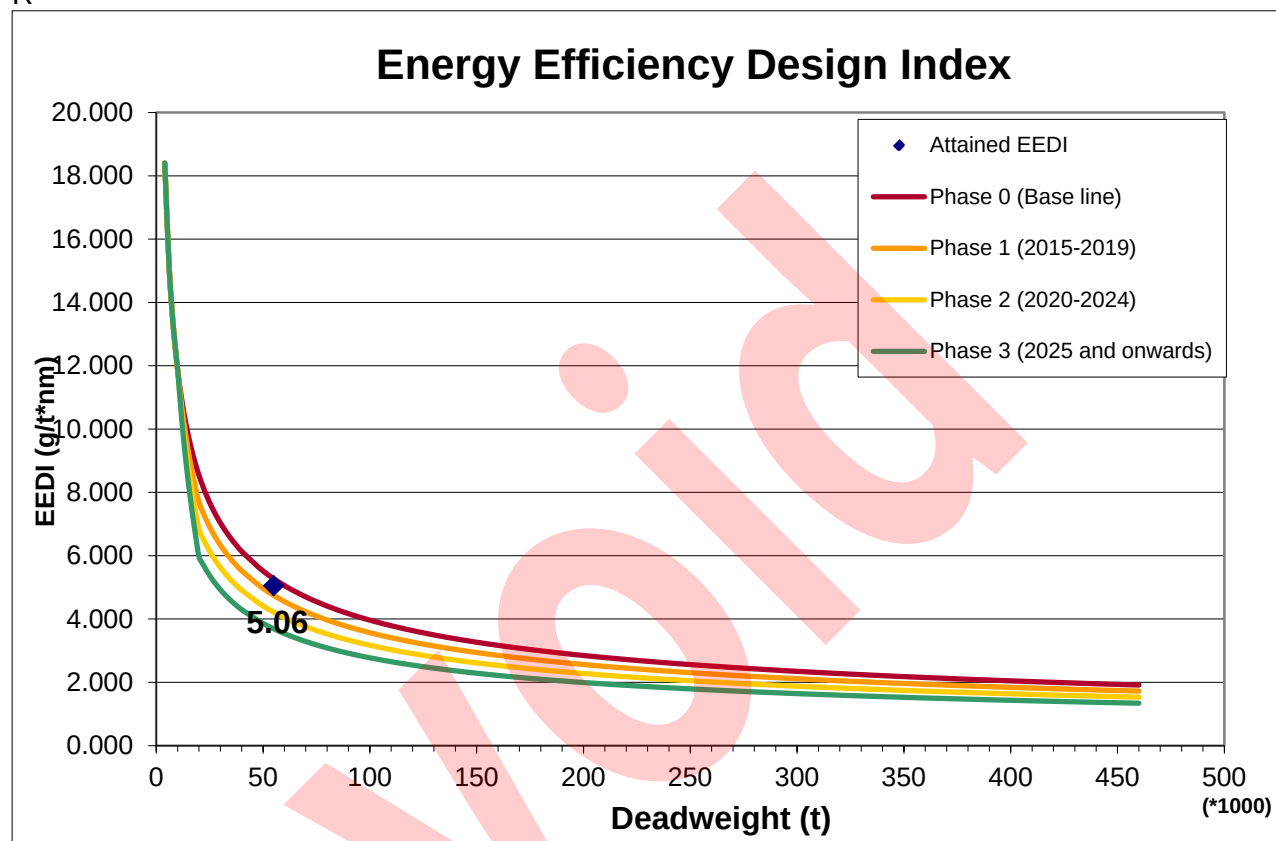


Figure 12.1: Required EEDI value

### 13 CALCULATION OF ATTAINED EEDI<sub>WEATHER</sub>

Not calculated.

### 14 LIGHTWEIGHT CHECK REPORT

The lightweight check report is provided in annex 6. The final characteristics of the ship are:

|              |             |
|--------------|-------------|
| Displacement | 66 171 tons |
| Lightweight  | 11 621 tons |
| Deadweight   | 54 550 DWT  |

### 15 SEA TRIAL REPORT WITH CORRECTIONS

The sea trial report is provided in annex 7. The results of the sea trial after corrections by BSRA and ITTC standard methods are given on curve *Ballast,s* on Figure 3.1.

## 16 CALCULATION OF ATTAINED EEDI AT FINAL STAGE

### 16.1 Recalculated values of parameters

The EEDI quantities and intermediate calculations are listed in table 16.1. Parameters which have not been modified from the preliminary verification stage are marked “no change”.

| EEDI quantity | Value       | Remarks                                                                                                                                                                                                                                             |
|---------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $C_{FME}$     | 3.206       | No change                                                                                                                                                                                                                                           |
| $P_{ME}$      | 6 900 kW    | No change                                                                                                                                                                                                                                           |
| $SFC_{ME}$    | 171 g/kWh   | No change                                                                                                                                                                                                                                           |
| $CF_{AE}$     | 3.206       | No change                                                                                                                                                                                                                                           |
| $P_{PTI}$     | 0           | No change                                                                                                                                                                                                                                           |
| $P_{AE}$      | 381 kW      | The electric power table has been validated and endorsed (see the electric power table form in annex 8)                                                                                                                                             |
| $SFC_{AE}$    | 205 g/kWh   | No change                                                                                                                                                                                                                                           |
| $P_{eff}$     | 0           | No change                                                                                                                                                                                                                                           |
| $P_{AEeff}$   | 0           | No change                                                                                                                                                                                                                                           |
| $f_{eff}$     |             | No change                                                                                                                                                                                                                                           |
| $f_i$         | 1.0         | No change                                                                                                                                                                                                                                           |
| $f_i$         | 1.017       | Deadweight and lightweight are computed from lightweight check:<br>$f_{iCSR} = 1 + 0.08 \cdot LWT_{CSR} / DWT_{CSR} = 1 + 0.08 \cdot 11621 / 54550 = 1.017$<br>$f_i = f_{iICE} \times f_{iVSE} \times f_{iCSR} = 1.017$ (unchanged)                 |
| $f_c$         | 1.0         | No change                                                                                                                                                                                                                                           |
| Capacity      | 54550 DWT   | Deadweight has been computed from the lightweight check. See 14.                                                                                                                                                                                    |
| $V_{ref}$     | 14.65 knots | The reference speed in EEDI condition has been adjusted according to the delivered power adjustment methodology defined in Industry Guidelines.<br>The reference speed is read on the speed curves diagram in Figure 3.1<br>$V_{ref} = 14.65$ knots |

Table 11.1: Parameters in attained EEDI calculation (final stage)

### 16.2 Final result

Attained EEDI =  $(6900 \cdot 3.206 \cdot 171 + 381 \cdot 3.206 \cdot 205) / (1.017 \cdot 54550 \cdot 14.65) = 4.96$  g/t.nm

Required EEDI in Phase 0:  $961.79 \cdot 54550^{-0.477} = 5.29$  g/t.nm

**Regulation criteria is satisfied with 6% margin**



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## List of annexes to the Document

|         |                                                                                                                 |
|---------|-----------------------------------------------------------------------------------------------------------------|
| Annex 1 | Standard model-ship extrapolation and correlation method                                                        |
| Annex 2 | Towing tank tests report                                                                                        |
| Annex 3 | Ship lines and offsets table                                                                                    |
| Annex 4 | Description of energy saving equipment                                                                          |
| Annex 5 | 5.1 NO <sub>x</sub> Technical File of main engine(s)<br>5.2 NO <sub>x</sub> Technical File of auxiliary engines |
| Annex 6 | Lightweight check report                                                                                        |
| Annex 7 | Sea trials report                                                                                               |
| Annex 8 | EPT-EEDI form                                                                                                   |

## **APPENDIX 3**

### **Verifying the calibration of model test equipment**

#### **Quality Control System**

The existence of a Quality Control System is not sufficient to guarantee the correctness of the test procedures; QS, including ISO 9000, only give documentary evidence what is to be and has been done. Quality Control Systems do not evaluate the procedures as such.

The Test institute is to have a quality control system (QS). If the QS is not certified ISO 9000 a documentation of the QS is to be shown. A Calibration Procedure is given in ITTC Recommended Procedures 7.6-01-01

#### **1. Measuring Equipment**

An important aspect of the efficient operation of Quality System according to measuring equipment is a full identification of devices used for the tests.

Measuring equipment instruments are to have their individual records in which the following data are to be placed:

- name of equipment
- manufacturer
- model
- series
- laboratory identification number ( optionally)
- status ( verified, calibration, indication )

Moreover the information about the date of last and next calibration or verification is to be placed on this record. All the data are to be signed by authorised officer.

#### **2. Measuring Standards**

Measuring standards used in laboratory for calibration purposes are to be confirmed (verified) by Weights and Measures Office at appropriate intervals (defined by the Weights and Measures Office).

All measuring standards used in laboratory for the confirmation purposes are to be supported by certificates, reports or data sheets for the equipment confirming the source, uncertainty and conditions under which the results were obtained.

#### **3. Calibration**

The calibration methods may differ from institution to institution, depending on the particular measurement equipment. The calibration shall comprise the whole measuring chain (gauge, amplifier, data acquisition system etc.).

The laboratory shall ensure that the calibration tests are carried out using certified measuring standards having a known valid relationship to international or nationally recognised standards.

##### **a) Calibration Report**

"Calibration reports" shall include:

- identification of certificate for measuring standards
  - description of environmental conditions
-

- calibration factor or calibration curve
- uncertainty of measurement
- minimum and maximum capacity" for which the error of measuring instrument is within specified (acceptable) limits.

#### b) Intervals of Confirmation

The measuring equipment (including measuring standards) is to be confirmed at appropriate (usually periodical) intervals, established on the basis of their stability, purpose and wear. The intervals are to be such that confirmation is carried out again prior to any probable change in the equipment accuracy, which is important for the equipment reliability. Depending on the results of preceding calibrations, the confirmation period may be shortened, if necessary, to ensure the continuous accuracy of the measuring equipment. The laboratory is to have specific objective criteria for decisions concerning the choice of intervals of confirmation.

#### c) Non - Conforming Equipment

Any item of measuring equipment

- that has suffered damage,
- that has been overloaded or mishandled,
- that shows any malfunction,
- whose proper functioning is subject to doubt,
- that has exceeded its designated confirmation interval, or
- the integrity of whose seal has been violated, is to be removed from service by segregation, clear labelling or cancelling.

Such equipment is not to be returned to service until the reasons for its nonconformity have been eliminated and it is confirmed again.

If the results of calibration prior to any adjustment or repair were such as to indicate a risk of significant errors in any of the measurements made with the equipment before the calibration, the laboratory shall take the necessary corrective action.

## 4. Instrumentation

Especially the documentation on the calibration of the following Instrumentation is to be shown.

#### a) Carriage Speed

The carriage speed is to be calibrated as a distance against time. Period between the calibrations is to be in accordance with the internal procedure of the towing tank test organisation.

#### b) Water Temperature

Measured by calibrated thermometer with certificate (accuracy 0.1°C).

#### c) Trim Measurement

Calibrated against a length standard. Period between the calibrations is to be in accordance with the internal procedure of the towing tank test organisation.

#### d) Resistance Test

Resistance Test is a force measurement. It is to be calibrated against a standard weight. Calibration normally before each test series.

e) Propulsion Test

During Self Propulsion Test torque, thrust and rate of revolutions are measured. Thrust and Torque are calibrated against a standard weight. Rate of revolution is normally measured by a pulse tachometer and an electronic counter which can be calibrated e.g. by an oscillograph.

Period between the calibrations is to be in accordance with the internal procedure of the towing tank test organisation.

f) Propeller Open Water Test

During Propeller Open Water Test torque, thrust and rate of revolutions are measured. Thrust and Torque are calibrated against a standard weight. Rate of revolution is normally measured by a pulse tachometer and an electronic counter which can be calibrated e.g. by an oscillograph.

Period between the calibrations is to be in accordance with the internal procedure of the towing tank test organisation.

Examples of documentation sheets are given in the Annexes 1 and 2:

Void

[illegible]

## ANNEX 2: SAMPLE OF CALIBRATION CERTIFICATE.

|                                |  |                                                              |  |                     |  |                                            |  |
|--------------------------------|--|--------------------------------------------------------------|--|---------------------|--|--------------------------------------------|--|
| <b>QM</b><br><b>4.10.6.2</b>   |  | <b>CALIBRATION CERTIFICATE</b>                               |  | <b>NO.</b>          |  | <input style="width: 100%;" type="text"/>  |  |
|                                |  | <b>for</b>                                                   |  | <b>LIN</b>          |  | <input style="width: 100%;" type="text"/>  |  |
|                                |  | <input style="width: 150px;" type="text" value="PROPELLER"/> |  |                     |  |                                            |  |
| Calibration Instructions       |  | <input style="width: 100px;" type="text"/>                   |  | Calibrated by :     |  | <input style="width: 100px;" type="text"/> |  |
| Date of calibration            |  | <input style="width: 100px;" type="text"/>                   |  | Checked by :        |  | <input style="width: 100px;" type="text"/> |  |
| <b>Measurement combination</b> |  |                                                              |  |                     |  |                                            |  |
| <b>DYNAMOMETER</b>             |  | Manufacturer                                                 |  | Model               |  | <input style="width: 100px;" type="text"/> |  |
| <b>LIN</b>                     |  | <input style="width: 100px;" type="text"/>                   |  | Date of purchased   |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Serial No                                                    |  | Last calibration    |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Work instruction                                             |  |                     |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
| <b>Cable</b>                   |  |                                                              |  |                     |  |                                            |  |
| <b>AMPLIFIER</b>               |  | Manufacturer                                                 |  | Model               |  | <input style="width: 100px;" type="text"/> |  |
| <b>L</b>                       |  | <input style="width: 100px;" type="text"/>                   |  | Date of purchased   |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Serial No                                                    |  | Type of transducer  |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Work instruction                                             |  | Frequency of excit. |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Excitation                                                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
| <b>Thrust :</b>                |  | Amp. gain                                                    |  | Zero not load       |  | <input style="width: 100px;" type="text"/> |  |
| <b>Torque :</b>                |  | Amp. gain                                                    |  | Zero not load       |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
| <b>Cable</b>                   |  |                                                              |  |                     |  |                                            |  |
| <b>A/C TRANSDUCER</b>          |  | Manufacturer                                                 |  | Model               |  | <input style="width: 100px;" type="text"/> |  |
| <b>L</b>                       |  | <input style="width: 100px;" type="text"/>                   |  | Date of purchased   |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Serial No                                                    |  | Certificate No      |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Work instruction                                             |  |                     |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |
|                                |  |                                                              |  |                     |  |                                            |  |
| <b>MEASUREMENT STANDARDS</b>   |  | Mass                                                         |  | Certificate No      |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Length arm of force                                          |  | Certificate No      |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | Voltmeter                                                    |  | Certificate No      |  | <input style="width: 100px;" type="text"/> |  |
|                                |  | <input style="width: 100px;" type="text"/>                   |  |                     |  | <input style="width: 100px;" type="text"/> |  |

| QM<br>4.10.6.2                                                      |  |                      |                      | CALIBRATION RESULTS  |                      |                      |  |
|---------------------------------------------------------------------|--|----------------------|----------------------|----------------------|----------------------|----------------------|--|
| Environmental condition                                             |  |                      |                      |                      |                      |                      |  |
| Place of test : <input type="text"/>                                |  |                      |                      |                      |                      |                      |  |
| Temperature :                                                       |  | initial              | <input type="text"/> | final                | <input type="text"/> |                      |  |
| Dampness :                                                          |  | initial              | <input type="text"/> | final                | <input type="text"/> |                      |  |
| Computation results of calibrations test                            |  |                      |                      |                      |                      |                      |  |
| Executed program                                                    |  | procedure            |                      | certificate NO.      |                      |                      |  |
| <input type="text"/>                                                |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
|                                                                     |  | <b>Thrust</b>        |                      | <b>Torque</b>        |                      |                      |  |
| Drift :                                                             |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Non Linearity errors :                                              |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Hysteresis :                                                        |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Precision errors :                                                  |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Total uncertainty :                                                 |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Calibration factor :                                                |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Calibration requests :                                              |  |                      |                      |                      |                      |                      |  |
| Specified limits of                                                 |  | <b>Thrust</b>        |                      | <b>Torque</b>        |                      |                      |  |
| errors :                                                            |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Maximum capacity :                                                  |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| Minimum capacity :                                                  |  | <input type="text"/> |                      | <input type="text"/> |                      |                      |  |
| <b>Note : tests and computations results are included in report</b> |  |                      |                      |                      |                      | <input type="text"/> |  |

Prepared by : ..... Approved by : ..... Date : .....

## APPENDIX 4

### Review and witnessing of model test procedures

The Model Tests is to be witnessed by the verifier. Special attention is to be given to the following items:

#### 1. Ship Model

##### Hydrodynamic Criteria

- a) *Model Size*: The model should generally be as large as possible for the size of the towing tank taking into consideration wall, blockage and finite depth effects, as well as model mass and the maximum speed of the towing carriage (ITTC Recommended Procedure 7.5-02-02-01 Resistance Test).
- b) *Reynolds Number*: The Reynolds Number is to be, if possible, above  $2.5 \times 10^5$ .
- c) *Turbulence Stimulator*: In order to ensure turbulent flow, turbulence stimulators have to be applied.

##### Manufacture Accuracy

With regard to accuracy the ship model is to comply with the criteria given in ITTC Recommended Procedure 7.5-01-01-01, Ship Models.

The following points are to be checked:

- a) *Main dimensions*,  $L_{PP}$ ,  $B$
- b) *Surface finish*, model is to be smooth. Particular care is to be taken when finishing the model to ensure that geometric features such as knuckles, spray rails, and boundaries of transom sterns remain well-defined
- c) *Stations and Waterlines* The spacing and numbering of displacement stations and waterlines are to be properly defined and accurately marked on the model.
- d) *Displacement* The model is to be run at the correct calculated displacement. The model weight is to be correct to within 0.2% of the correct calculated weight displacement. In case the marked draught is not met when the calculated displacement has been established the calculation of the displacement and the geometry of the model compared to the ship has to be revised. (Checking the Offsets).

##### Documentation in the report

Identification (model number or similar)  
Materials of construction  
Principal dimensions  
Length between perpendiculars ( $L_{PP}$ )  
Length of waterline ( $L_{WL}$ )  
Breadth ( $B$ )  
Draught ( $T$ )  
For multihull vessels, longitudinal and transverse hull spacing  
Design displacement ( $\Delta$ ) (kg, fresh water)  
Hydrostatics, including water plane area and wetted surface area  
Details of turbulence stimulation  
Details of appendages  
Tolerances of manufacture

---



## 2. Propeller Model

The Manufacturing Tolerances of Propellers for Propulsion Tests are given IN ITTC Recommended Procedures 7.5-01-01-01, Ship Models Chapter 3.1.2. Attention: Procedure 7.5 – 01-02-02 Propeller Model Accuracy is asking for higher standards which are applicable for cavitation tests and not required for self-propulsion tests.

### Propeller Model Accuracy

#### **Stock Propellers**

During the “stock-propeller” testing phase, the geometrical particulars of the final design propeller are normally not known. Therefore, the stock propeller pitch (in case of CPP) is recommended to be adjusted to the anticipated propeller shaft power and design propeller revolutions. (ITTC Recommended Procedure 7.5-02-03-01.1 Propulsion/Bollard Pull Test).

#### **Adjustable Pitch Propellers**

Before the Tests the pitch adjustment is to be controlled.

#### **Final Propellers**

Propellers having diameter (D) typically from 150 mm to 300 mm is to be finished to the following tolerances:

Diameter (D)  $\pm 0.10$  mm

Thickness (t)  $\pm 0.10$  mm

Blade width (c)  $\pm 0.20$  mm

Mean pitch at each radius (P/D):  $\pm 0.5\%$  of de-sign value.

Special attention is to be paid to the shaping accuracy near the leading and trailing edges of the blade section and to the thickness distributions. The propeller will normally be completed to a polished finish.

#### **Documentation in the report**

Identification (model number or similar)  
 Materials of construction  
 Principal dimensions  
 Diameter  
 Pitch-Diameter Ratio ( $P/D$ )  
 Expanded blade Area Ratio ( $A_E/A_0$ )  
 Thickness Ratio ( $t/D$ )  
 Hub/Boss Diameter ( $d_h$ )  
 Tolerances of manufacture

## 3. Model Tests

### a) Resistance Test

The Resistance Test is to be performed acc. to ITTC Recommended Procedure 7.5-02-02-01 Resistance Test.

#### **Documentation in the report**

*Model Hull Specification:*

- Identification (model number or similar)
- Loading condition
- Turbulence stimulation method
- Model scale
- Main dimensions and hydrostatics (see ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 2 of this paper).

*Particulars of the towing tank*, including length, breadth and water depth

*Test date*

*Parametric data for the test:*

- Water temperature
- Water density
- Kinematic viscosity of the water
- Form factor (even if  $(1+k) = 1.0$  is applicable, this is to be stated)
- $\Delta C_F$  or  $C_A$

*For each speed*, the following measured and extrapolated data is to be given as a minimum:

- Model speed
- Resistance of the model
- Sinkage fore and aft, or sinkage and trim

## **b) Propulsion Test**

The Propulsion Test is to be performed acc. to ITTC Recommended Procedure 7.5-02-03-01.1 Propulsion Test/Bollard Pull.

### **Documentation in the report**

*Model Hull Specification:*

- Identification (model number or similar)
- Loading condition
- Turbulence stimulation method
- Model scale
- Main dimensions and hydrostatics (see ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 2 of this paper).

*Model Propeller Specification*

- Identification (model number or similar)
- Model Scale
- Main dimensions and particulars (see ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 3 of this paper)

*Particulars of the towing tank*, including length, breadth and water depth

*Test date*

*Parametric data for the test:*

- Water temperature
- Water density
- Kinematic viscosity of the water
- Form factor (even if  $(1+k) = 1.0$  is applicable, this is to be stated)
- $\Delta C_F$  or  $C_A$
- Appendage drag scale effect correction factor (even if a factor for scale effect correction is not applied, this is to be stated).

*For each speed* the following measured data and extrapolated data is to be given as a minimum:

- Model speed
  - External tow force
  - Propeller thrust,
  - Propeller torque
  - Rate of revolutions.
  - Sinkage fore and aft, or sinkage and trim
-

- The extrapolated values are also to contain the resulting delivered power  $P_D$ .

### c) Propeller Open Water Test

In many cases the Propeller Open Water Characteristics of a stock propeller will be available and the Propeller Open Water Test need not be repeated for the particular project. A documentation of the Open Water Characteristics (Open Water Diagram) will suffice.

In case of a final propeller or where the Propeller Open Water Characteristics is not available the Propeller Open Water Test is to be performed acc. to ITTC Recommended Procedure 7.5-02-03-02.1 Open Water Test.

### Documentation in the report

#### *Model Propeller Specification:*

- Identification (model number or similar)
- Model scale
- Main dimensions and particulars (see recommendations of ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 3 of this paper)
- Immersion of centreline of propeller shaft in the case of towing tank

*Particulars of the towing tank or cavitation tunnel*, including length, breadth and water depth or test section length, breadth and height.

#### *Test date*

#### *Parametric data for the test:*

- Water temperature
- Water density
- Kinematic viscosity of the water
- Reynolds Number (based on propeller blade chord at  $0.7R$ )

*For each speed* the following data is to be given as a minimum:

- Speed
- Thrust of the propeller
- Torque of the propeller
- Rate of revolution
- Force of nozzle in the direction of the propeller shaft (in case of ducted propeller)

#### *Propeller Open Water Diagram*

#### 4. Speed Trial Prediction

The principal steps of the Speed Trial Prediction Calculation are given in ITTC Recommended Procedure 7.5 - 02 - 03 -1.4 ITTC 1978 Trial Prediction Method (in its latest reviewed version of 2011). The main issue of a speed trial prediction is to get the loading of the propeller correct and also to assume the correct full scale wake. The right loading of the propeller can be achieved by increasing the friction deduction by the added resistance (e.g. wind resistance etc.) and run the self-propulsion test already at the right load or it can be achieved by calculation as given in Procedure 7.5-02-03-1.4.

A wake correction is always necessary for single screw ships. For twin screw ships it can be neglected unless the stern shape is of twin hull type or other special shape.

The following scheme indicates the main components of a speed trial prediction. It is to be based on a Resistance Test, a Propulsion Test and an Open Water Characteristics of the used model propeller during the tests and the Propeller Open Water Characteristics of the final propeller.

##### Documentation

###### *Model Hull Specification:*

- Identification (model number or similar)
- Loading condition
- Turbulence stimulation method
- Model scale
- Main dimensions and hydrostatics (see ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 2 of this paper).

###### *Model Propeller Specification*

- Main dimensions and particulars (see ITTC Recommended Procedure 7.5-01-01-01 Ship Models and chapter 3 of this paper)

*Particulars of the towing tank, including length, breadth and water depth*

*Resistance Test Identification (Test No. or similar)*

*Propulsion Test Identification (Test No. or similar)*

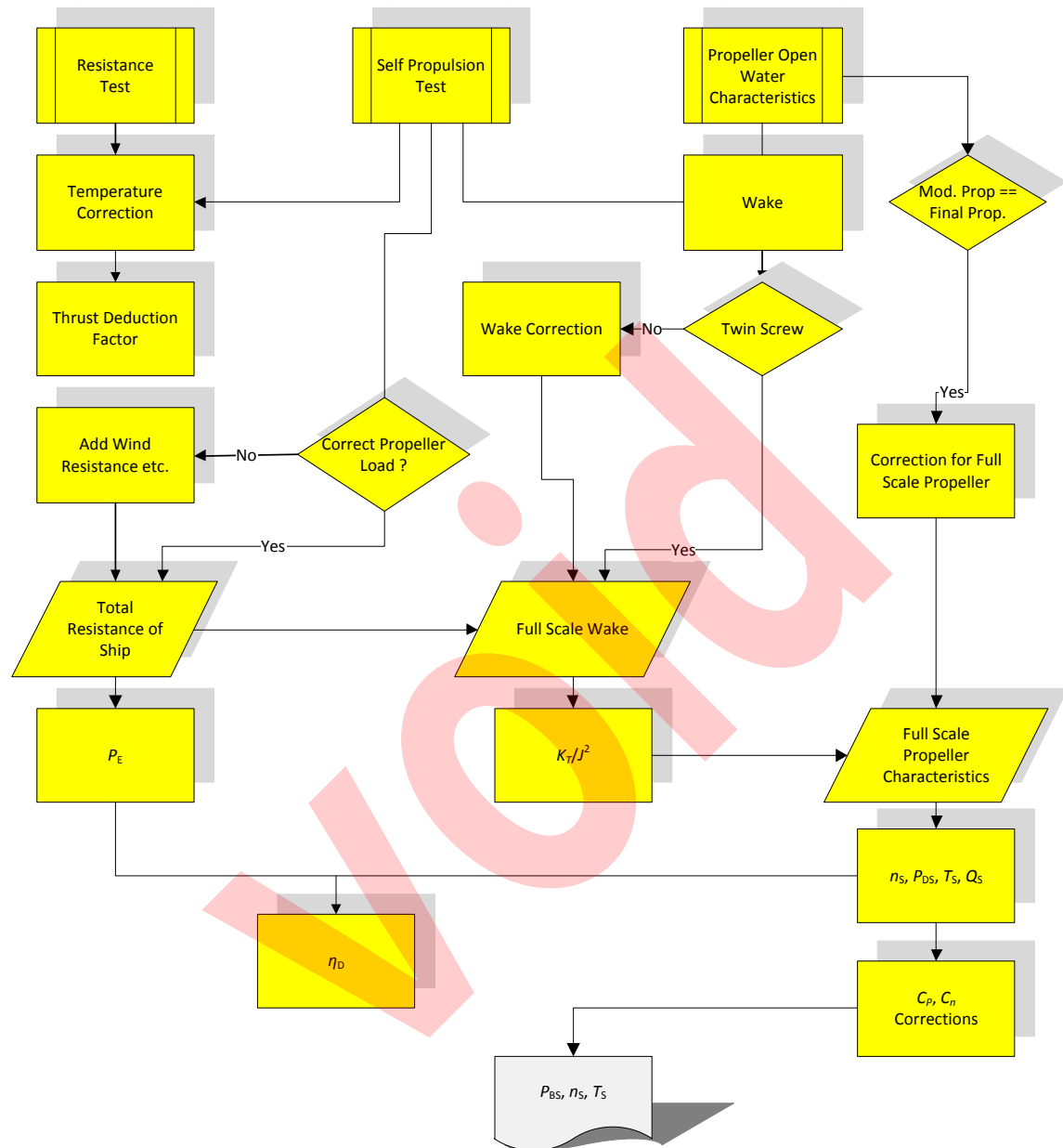
*Open Water Characteristics of the model propeller*

*Open Water Characteristics of ship propeller*

###### *Ship Specification:*

- Projected wind area
  - Wind resistance coefficient
  - Assumed BF
  - $C_P$  and  $C_n$
-

## Principle Scheme for Speed Trial Prediction



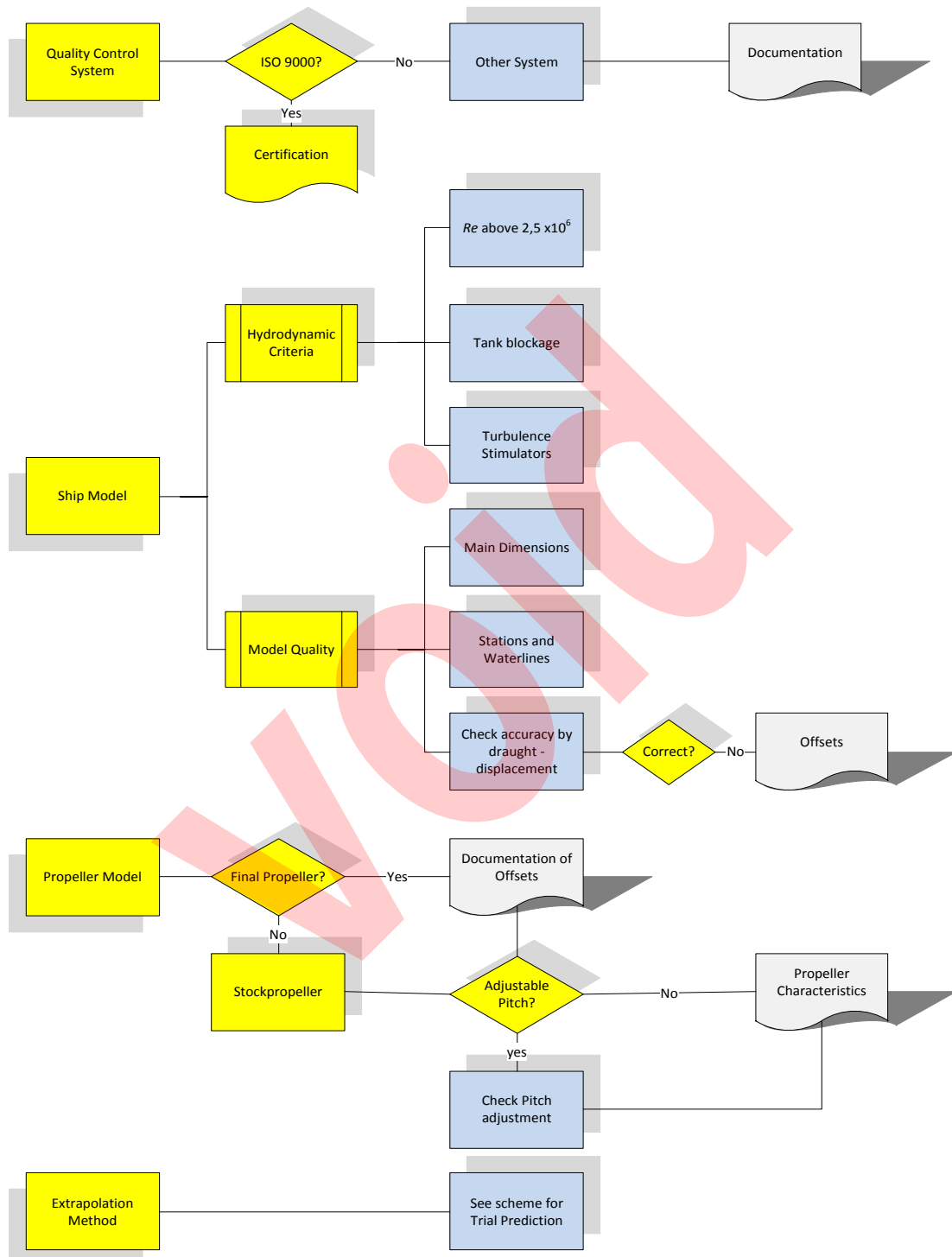
*For each speed* the following *calculated data* is to be given as a minimum:

- Ship speed
- Model wake coefficient
- Ship wake coefficient
- Propeller thrust on ship
- Propeller torque on ship
- Rate of revolutions on ship
- Predicted power on ship (delivered power on Propeller(s)  $P_D$ )
- Sinkage fore and aft, or sinkage and trim

VOID

## Scheme for review and witnessing Model Tests

### Checking of Model Testing Procedure



## APPENDIX 5

### Sample report “Preliminary Verification of EEDI”

#### ATTESTATION

#### PRELIMINARY VERIFICATION OF ENERGY EFFICIENCY DESIGN INDEX (EEDI)

by **VERIFIER**

Statement N° EEDI/2012/XXX

**Ship particulars:**

Ship Owner: \_\_\_\_\_

Shipyard: \_\_\_\_\_

Ship's Name: \_\_\_\_\_

IMO Number: \_\_\_\_\_

Hull number: \_\_\_\_\_

Building contract date: \_\_\_\_\_

Type of ship: \_\_\_\_\_

Port of registry: \_\_\_\_\_

Deadweight: \_\_\_\_\_

**Summary results of EEDI**

|                 |             |
|-----------------|-------------|
| Reference speed | VV.V knots  |
| Attained EEDI   | X.XX g/t.nm |
| Required EEDI   | Y.YY g/t.nm |

**Supporting documents**

| Title               | ID and/or remarks     |
|---------------------|-----------------------|
| EEDI Technical File | RRRR dated 01/01/2013 |

This is to certify:

1. That the attained EEDI of the ship has been calculated according to the *2012 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships*, IMO Resolution MEPC.212(63)
2. That the preliminary verification of the EEDI shows that the ship complies with the applicable requirements in regulation 20 and regulation 21 of MARPOL Annex VI amended by Resolution MEPC.203(62).

Completion date of preliminary verification of EEDI: xx/xx/xxxx

Issued at: \_\_\_\_\_ on: \_\_\_\_\_

Signature of the Verifier