Guide for the Evaluation of Energy Efficiency Existing Ship Index (EEXI)

Effective from 1 November 2024

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GENERAL CONDITIONS

Definitions:

Administration" means the Government of the State whose flag the ship is entitled to fly or under whose authority the ship is authorized to operate in the specific case.

"**IACS**" means the International Association of Classification Societies.

"Interested Party" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the shipbuilder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"**Owner**" means the registered owner, the shipowner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the Specific Rules.

"**Rules**" in these General Conditions means the documents below issued by the Society:

(i) Rules for the Classification of Ships or other special units.
(ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
(iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations.
(iv) Guides to carry out particular activities connected with Services;
(v) Any other technical document, for example, rule variations or interpretations.

"Services" means the activities described in paragraph 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"**Ship**" means ships, boats, craft and other special units, for example, offshore structures, floating units and underwater craft.

"Society" or "TASNEEF" means TASNEEF Maritime

"**Surveyor**" means technical staff acting on behalf of the Society in performing the Services.

"**Force Majeure**" means damage to the ship; unforeseen inability of the Society to attend the ship due to government restrictions on right of access or movement of personnel; unforeseeable delays in port or inability to discharge cargo due to unusually lengthy periods of severe weather, strikes or civil strife; acts of war; or other force majeure.

1. Society Roles

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
(i) sets forth and develops Rules.
(ii) publishes the Register of Ships.
(iii) Issues certificates, statements and reports based on its survey activities.
1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various Governments.
1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which is regulated by these general conditions unless expressly excluded in the particular contract.

2. Rule Development, Implementation and Selection of Surveyor

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published therefore, the Society, although also committed through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.
2.2. The Interested Party is required to know the Rules based on which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatement. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.
2.3. Society exercises due care and skill:
(i) In the selection of its Surveyors
(ii)In the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.
2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

3. Class Report & Interested Parties Obligation

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of the specific scope of the Service requested by the Interested Party or on its behalf.
3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as part of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorized bodies and no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties based on the statements or information given by the Society.
The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.
3.3. The classification of a Ship or the issuance of a certificate or other document connected with classification or certification and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaworthiness, structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society about its activities reflects the condition of the Ship or the subject of certification or other activity at the time of the check.
3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, shipbuilders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, the Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.
In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.
In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third-party claim, as well as from any liability about the latter concerning the Services rendered.
Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties concerning the services rendered by the Society are described in the Rules applicable to the specific service rendered.

4. Service Request & Contract Management

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2 In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested.

4.3 The contractor for the classification of a ship or for the services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30/60/90 days' notice, to be given in writing. Failure to pay, even in part, the fees due for services carried out by the society will entitled the society to immediately terminate the contract and suspend the service.
For every termination of the contract, the fees for the activities performed until the time of the termination shall be owned to the society as well as the expenses incurred in view of activities already programmed, this is without prejudice to the right to compensation due to the society as a consequence of the termination.
With particular reference to ship classification and certification, unless decided otherwise by the society, termination of the contract implies that the assignment of class to a ship is withheld or, if already assigned, that it is suspended or withdrawn, any statutory certificates issued by society will be withdrawn in those cases where provided for by agreements between the society and the flag state.

5. Service Accuracy

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see **Rule Development, Implementation and Selection of Surveyor** 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

6. Confidentiality & Document sharing

6.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorization of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.
Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

6.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 below, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.
6.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual-class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained about the provision of plans and drawings to the new Society, either by way of the appropriate stipulation in the building contract or by other agreement.
In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

7. Health, Safety & Environment

7.1. The clients such as the designers, shipbuilders, manufacturers, repairers, suppliers, contractors or sub-contractors, or other product or system surveyed who have a registered office in ABU Dhabi; should have an approved OSHAD as per Abu Dhabi OHS Centre, or, if they do not need to have an approved OSHAD, they shall comply with TASNEEF standards and have procedures in place to manage the risks from their undertakings.

7.2. For the survey, audit and inspection activities onboard the ship, the ship's owner, the owner representative or the shipyard must follow TASNEEF rules regarding the safety aspects.

8. Validity of General Conditions

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

9. Force Majeure

9.1 Neither Party shall be responsible to the other party for any delay or failure to carry out their respective obligations insofar as such delay and failure derives, directly or indirectly, and at any time, from force majeure of any type whatsoever that lies outside the control of either Party.

9.2 The Party that is unable to fulfil the agreement due to Force Majeure shall inform the other party without delay and in all cases within 7 days from when such force majeure arose.

9.3 It is understood that if such force majeure continues for more than 30 days, the Party not affected by the event may terminate this agreement by registered letter. The rights matured until the day in which the force majeure occurred remain unaffected.

10. Governing Law and Jurisdiction

This Agreement shall be governed by and construed in accordance with the laws of Abu Dhabi and the applicable Federal Laws of the UAE.
Any dispute arising out of or in accordance with this Agreement shall be subject to the exclusive jurisdiction of the Abu Dhabi courts.

11. Code of Business conduct

The **CLIENT** declares to be aware of the laws in force about the responsibility of the legal persons for crimes committed in their interest or to their own advantage by persons who act on their behalf or cooperate with them, such as directors, employees or agents.
In this respect, the **CLIENT** declares to have read and fully understood the "**Ethical Code**" published by **TASNEEF** and available in the **TASNEEF** Web site.
The **CLIENT**, in the relationships with **TASNEEF**, guarantees to refrain from any behaviour that may incur risk of entry in legal proceedings for crimes or offences, whose commission may lead to the enforcement of the laws above.
The **CLIENT** also acknowledges, in case of non-fulfilment of the previous, the right of **TASNEEF** to unilaterally withdraw from the contract/agreement even if there would be a work in progress situation or too early terminate the contract/agreement. It's up to **TASNEEF** to choose between the two above mentioned alternatives, and in both cases a registered letter will be sent with a brief sum-up of the circumstances or of the legal procedures proving the failure in following the requirements of the above-mentioned legislation.

In light of the above, it is forbidden to all employees and co-operators to:
- receive any commission, percentage or benefits of any possible kind;
- Start and maintaining any business relationship with **Clients** that could cause conflict of interests with their task and function covered on behalf of **TASNEEF.**
- Receive gifts, travel tickets or any other kind of benefits different from monetary compensation, that could exceed the ordinary business politeness.

Violation of the above-mentioned principles allows **TASNEEF** to early terminate the contract and to be entitled to claim compensation for losses if any.

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1 SCOPE

The scope of this Guide is to provide both Tasneef technicians and shipowners with a common approach for the implementation of the upcoming energy efficiency MARPOL requirements, applicable to new and existing ships.

The approach in this Guide is applicable, unless instructed otherwise by the ship's Flag Administration.

The differences between the August 2022 version of the Guide and the one issued in October 2021 are:

- Various paragraphs throughout the whole document have been updated based on the IMO Resolutions adopted by Resolution MEPC 78 (June 2022) and aligned to IACS Rec. No.172 (June 2022) "EEXI Implementation Guidelines".
- Paragraph 2.1: a clarification on ship types for which Required and Attained EEXI is not applicable has been added.
- Paragraph 2.2: the list of references has been updated.
- Paragraph 4.8: references to in-service performance measurements as per MEPC.1/Circ.901 have been added.

The differences between this version of the Guide and the one issued in August 2022 are:

- Various paragraphs throughout the whole document have been updated based on the publication of IACS Rec. No.172 Rev.1 (April 2024) "EEXI Implementation Guidelines" and the adoption of Resolution MEPC.375(80) and Resolution MEPC.390(81) amending MEPC.335(76) "2021 Guidelines on the shaft/engine power limitation system to comply with the EEXI requirements and use of a power reserve".

2 GENERAL

2.1 MARPOL Annex VI amendments

The amendments to MARPOL Annex VI, adopted by Resolution MEPC.328(76) and entering into force on 1 November 2022, require the following new and existing ships of 400 GT and above having conventional propulsion (except when indicated otherwise):

- bulk carriers;
- gas carriers;
- tankers;
- container ships;
- general cargo ships;
- refrigerated cargo carriers;
- combination carriers;
- LNG carriers having conventional and non-conventional propulsion;
- ro-ro cargo ships (vehicle carrier);
- ro-ro cargo ships;
- ro-ro passenger ships;
- cruise passenger ships only having non-conventional propulsion

to calculate the Attained EEXI which shall result equal or less than the Required EEXI (see [3] and [4] for details).

In case of ships having non-conventional propulsion (diesel/electric, turbine or hybrid), the requirements to calculate an Attained EEXI and to comply with a Required EEXI are normally not applicable, but apply to cruise passenger ships having non-conventional propulsion and LNG carriers having conventional or non-conventional propulsion. Also, the requirements do not apply to category A ships as defined in the Polar Code as well as livestock carriers, barge carriers, heavy load carriers, yacht carriers and nuclear fuel carriers as provided for in MARPOL Annex VI Regulation 2.2.15.

For the definition of "heavy load carriers" please refer to IACS Rec. No. 170 (May 2022) "The term of "heavy load carrier" for the application of EEDI/EEXI and CII".

The verification of the ship's Attained EEXI, based on an EEXI Technical File, is to take place at the first annual, intermediate or renewal survey of the IAPP Certificate or the initial survey of the IEEC Certificate, whichever is the first, on or after **1 January 2023.**

A sample of the EEXI Technical File is provided in Appendix 1 of this Guide.

2.2 References

This Guide refers to the following IMO and IACS requirements and guidelines:

- IMO Resolution MEPC.254(67) - 2014 Guidelines on survey and certification of the energy efficiency design index (EEDI), as amended by Resolutions MEPC.261(68) and MEPC.309(73)

- IMO Resolution MEPC.364(79) - 2022 Guidelines on the method of calculation of the Attained Energy Efficiency Design Index (EEDI) for new ships
- IMO Resolution MEPC.328(76) - Amendments to MARPOL Annex VI
- IMO Resolution MEPC.335(76) - 2021 Guidelines on the shaft/engine power limitation system to comply with the EEXI requirements and use of a power reserve, as amended by MEPC.375(80) and MEPC.390(81)
- IMO Resolution MEPC.350(78) - 2022 Guidelines on the method of calculation of the Attained Energy Efficiency Existing Ship Index (EEXI)
- IMO Resolution MEPC.351(78) - 2022 Guidelines on survey and certification of the Energy Efficiency Existing Ship Index (EEXI)
- IMO Circular MEPC.1/Circ.850/Rev.3 – Guidelines for determining minimum propulsion power to maintain the maneuverability of ships in adverse conditions
- IMO Circular MEPC.1/Circ.896 - 2021 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the Attained EEDI
- IMO Circular MEPC.1/Circ.901 – Guidance on methods, procedures and verification of in-service performance measurements
- IACS Rec. No.172 (Rev.1, April 2024) – EEXI Implementation Guidelines
- IACS Rec. No 173 (Nov 2022) - Guidelines on Numerical Calculations for the purpose of deriving the Vref in the framework of the EEXI Regulation.

3 REQUIRED EEXI EVALUATION

3.1 Formula for Required EEXI

The formula for Required EEXI is:

Required EEXI = (1-Y/100) * EEDI reference line value

where:

EEDI Reference line value = $a * b^{-c}$
a, b and c are depending on ship type (and size in some cases) as per Table 1.

Table 1

Ship type	a	b	c
Bulk carrier	961.79	- DWT of the ship where DWT≤279,000 - 279,000 where DWT > 279,000	0.477
Gas carrier	1120	DWT of the ship	0.456
Tanker	1218.80	DWT of the ship	0.488
Container ship	174.22	DWT of the ship	0.201
General cargo ship	107.48	DWT of the ship	0.216
Refrigerated cargo carrier	227.01	DWT of the ship	0.244
Combination carrier	1219.00	DWT of the ship	0.488
Ro-ro cargo ship (vehicle carrier)	- 780.36* (DWT/GT)^(-0.7) where DWT/GT < 0.3 - 1812.63 where DWT/GT >= 0.3	DWT of the ship	0.471
Ro-ro cargo ship	1686.17	- DWT of the ship where DWT <= 17000 - 17000 where DWT > 17000	0.498
Ro-ro passenger ship	902.59	- DWT of the ship where DWT <= 10000 - 10000 where DWT > 10000	0.381
LNG carrier	2253.7	DWT of the ship	0.474
Cruise passenger ship having non-conventional propulsion	170.84	GT of the ship	0.214

The ship type should match the ship type mentioned in the IEE Certificate, except for LNG Carriers that were categorized as Gas Carriers and Cruise Passenger Ships that were categorized as Passenger Ships under Phase 1 of EEDI. Some ship sizes may have only an Attained EEXI without a Required EEXI (e.g. a bulk carrier of 5,000

DWT is subject to attained EEXI, but not the required EEXI). For further guidance on the EEXI assessment of LNG carriers that were delivered before 1 September 2019 (as gas carrier), refer to paragraph 7.1 of IACS Rec. No. 172.

The reduction factor of Required EEXI for cruise passenger ships with conventional propulsion is not specified in MARPOL Convention at this stage. Cruise passenger ships with conventional propulsion are therefore excluded from calculation of Required EEXI and from compliance with:

Attained EEXI $\leq$ Required EEXI.

Cement carriers should be classified as Bulk Carriers within the scope of MARPOL Annex VI, unless otherwise agreed by the flag state, either in response to a specific owner's request or as per previously issued general instructions.

If, upon flag instruction, the cement carrier is categorized differently from a bulk carrier, the following criteria must be verified:

- The Statement of Compliance for the carriage of solid bulk cargoes should list only "cement".
- The Cargo Ship Safety Certificate * can't indicate "bulk carrier" in the "type of ship". The ship type specified on the certificate should correspond to the flag's instructions.

** or alternatively Cargo Ship Safety Construction Certificate and Cargo Ship Safety Equipment Certificate.*

3.2 Reduction factors

In the formula for Required EEXI:

Required EEXI = (1-Y/100) * EEDI reference line value

Y is the reduction factor, ship-type specific and depending on ship size (DWT or GT), as per Table 2.

Table 2

Ship type	Size	Reduction factor	Equivalent to Required EEDI Phase … (see Note 1)
Bulk carrier	DWT >= 200,000	15	1 +
	20,000 <=DWT < 200,000	20	2
	10,000 <= DWT < 20,000	0-20	2
Gas carrier	DWT >= 15,000	30	3
	10,000 <= DWT < 15,000	20	2
	2,000 <= DWT < 10,000	0-20	2
Tanker	DWT >= 200,000	15	1 +
	20,000 <= DWT < 200,000	20	2
	4,000 <= DWT < 20,000	0-20	2
Container ship	DWT >= 200,000	50	3
	120,000 <= DWT < 200,000	45	3
	80,000 <= DWT < 120,000	35	2++
	40,000 <= DWT < 80,000	30	2+
	15,000 <= DWT < 40,000	20	2
	10,000 <= DWT < 15,000	0-20	2
General cargo ship	DWT >= 15,000	30	3
	3,000 <= DWT < 15,000	0-30	3
Refrigerated cargo carrier	DWT >= 5,000	15	2
	3,000 <= DWT < 5,000	0-15	2
Combination carrier	DWT >= 20,000	20	2
	4,000 <= DWT < 20,000	0-20	2
Ro-ro cargo ship (vehicle carrier)	DWT >= 10,000	15	2
Ro-ro cargo ship	DWT >= 2,000	5	1
	1,000 <= DWT < 2,000	0-5	1
Ro-ro passenger ship	DWT >= 1,000	5	1
	250 <= DWT < 1,000	0-5	1
LNG carrier	DWT >= 10,000	30	3
Cruise passenger ship having non-conventional propulsion	GT >= 85,000	30	3
	25,000 <= GT < 85,000	0-30	3

Note: where in column “Equivalent to Required EEDI Phase …” is indicated a number with “+” or “++” it means that it is more stringent than the corresponding EEDI phase but lower than the next Phase (e.g. “2+” means that it is more stringent than Phase 2 but less than Phase 3).

For those ships below the threshold identified by Table 2, the Required EEXI has not to be calculated and compared with the Attained EEXI. In this case, the Attained EEXI value only will be included in the EEXI technical file.

4 ATTAINED EEXI EVALUATION

Ships falling into the scope of EEDI requirement can use their certified Attained EEDI (as documented in the IEE Certificate) as an alternative to the Attained EEXI, providing it satisfies the Required EEXI. If verification is based on EEDI TF which has been approved by another Classification Society different from the one re-issuing the new IEE Certificate, the supporting documentation should include:

- the approved EEDI Technical File,
- a copy of the IEEC Supplement and/or approval letter
- a statement that the ship has not undergone major modification as defined in MARPOL Annex VI, Reg.2.2.17.

In all other cases, the EEXI is to be calculated as described in this chapter.

4.1 EEXI formula

$$\textbf{EEXI} = \frac{\left[\begin{array}{c}\left(\prod_{j=1}^{n} f_j\right)*\left(\sum_{i=1}^{nME} P_{ME(i)}*C_{FME(i)}*SFC_{ME(i)}\right)+\left(P_{AE}*C_{FAE}*SFC_{AE}^{(1)}\right)+\\ \left(\left(\prod_{j=1}^{n} f_j*\sum_{i=1}^{nPTI} P_{PTI(i)}-\sum_{i=1}^{neff} f_{eff(i)}*P_{AEeff(i)}\right)*C_{FAE}*SCF_{AE}\right)-\\ \left(\sum_{i=1}^{neff} f_{eff(i)}*P_{eff(i)}*C_{FME}*SFC_{ME}\right)\end{array}\right]}{f_c*f_i*f_l*Capacity*f_w*V_{ref}*f_m}$$

(1) If part of the Normal Maximum Sea Load is provided by shaft generators, SFC_{ME} and CF_{ME} may – for that part of the power – be used instead of SFC_{AE} and C_{FAE}

In case (an) error(s) is/are found in the original EEDI Technical File which was approved at the time of delivery of the ship, then – for cases where a power limitation is implemented to satisfy the Required EEXI – the Attained EEXI will need to be calculated based on the correct data and an EEXI Technical File to be reviewed/approved.

For calculation of the Attained EEXI by the above formula, the parameters in Resolution MEPC.364(79), as amended apply, unless expressly provided otherwise.
The main parameters are explained in [4.2] to [4.10].

4.2 P_{ME} and Power Limitation

$P_{ME(i)}$ is normally 75% of the rated installed power (MCR) for each main engine (i).

The value of *MCR* specified on the EIAPP certificate (normally the rated power as indicated on the engine nameplate) is to be used for calculation.
If the main engines are not required to have an EIAPP certificate, the *MCR* on the nameplate is to be used; in case the nameplate is unavailable or illegible, the value as indicated on a valid Statutory certificate (e.g. International Tonnage certificate), or on a test report or certificate endorsed/issued by a Classification Society for the specific engine is to be used.

Whilst Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) only defines overridable power limitations, IACS Rec. No. 172 also defines a number of power limitation cases that are considered non-overridable or “permanent during ship operation”, as follows:

A) Overridable Power Limitation

- EPL (All power limitation measures that are equivalent to power limitation as described in Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) regarding limitation method, are to be regarded as overridable. This means in detail that all limitation of the fuel rack is considered in this way, independent from whether the crew can easily remove the blockage by breaking a seal or a tool is needed to remove the mechanical blockage)
- ShaPoLi
- Turbo Charger cut out by means of butterfly valve

In case overridable Shaft or Engine Power Limitation is installed in accordance with Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81), $P_{ME(i)}$ is equal to 83% of the limited installed power (MCR_{lim}) or 75% of the original installed power (MCR), whichever is lower, for each main engine (i), except for the case of overridable power limitation and shaft generators as detailed in IACS Rec.172 para 6.1 and below.

B) Non-overridable Power Limitation or "permanent during ship operation"

- Propeller retrofit with shaft power limitation to prevent damage on the propeller or shaft (see Note 1 below)
- Turbocharger dismantling (see Note 1 below)
- Turbocharger cut-out by removable (bolted) blinding plate, or permanent (welded) blinding plate (see Notes 1 and 2 below)
- Permanent adjustment of fuel index (see Notes 1 and 2 below)
- Permanent Engine derating, i.e. cylinder cut-off, reduction of combustion volume (see Note 1 below).

Note 1: The 75% approach is applicable.

Note 2: All the following provisions to be satisfied:

a. Permanent physical sealing subject to annual survey.
b. Description of the power limitation to be included in the EEXI Technical File.
c. The limited power value is to be stated in the EEXI Technical File and if applicable, in the reissued EIAPP.

For both EEDI and pre-EEDI bulk carriers, tankers, and combination carriers of 20,000 DWT and above, undergoing Non-overridable Power Limitation, the Minimum Propulsion Power Assessment is to be verified according to MEPC.1/Circ.850/Rev.3.
Also, the existing manoeuvring booklet, if available, and the manoeuvring information displayed on the navigating bridge (pilot card and wheelhouse poster) should be updated.

In case of non-overridable Shaft or Engine Power Limitation, $P_{ME(i)}$ is calculated according to Option 2 in paragraph 2.2.5.2 of Resolution MEPC.364(79), meaning that $P_{ME(i)}$ is equal to 75% of the limited installed power (MCR_{lim}).

Depending on the power limitation method, different MCR values are to be considered in the EEXI formula according to Table 3.

Table 3

Parameter	**Source**		**Variable**	**Overridable** [1]	**Non-overridable other than propeller retrofit** [2]	**Non-overridable propeller retrofit** [3]
	Reference	**Paragraph**		**function of**	**function of**	**function of**
P_{ME}	MEPC.350(78)	2.2.1				
	MEPC.364(79)	2.2.5.1	MCR_{lim}	$83\%\ MCR_{lim}$	$75\%\ MCR_{lim}$	$75\%\ MCR_{lim}$
	MEPC. 364(79)	2.2.5.2				
P_{AE}	MEPC. 364(79)	2.2.5.6	MCR	MCR	MCR_{lim}	MCR
$f_{j,ICE}$	MEPC. 364(79)	2.2.8.1	MCR	MCR	MCR_{lim}	MCR
$f_{j,RoRo}$	MEPC.350(78)	2.2.6	$V_{ref,F}$	$75\%\ MCR$	$P_{ME}= f(MCR_{lim})$	$P_{ME}= f(MCR_{lim})$
	MEPC. 364(79)	2.2.8.3	V_{ref}			
$f_{j,GeneralCargo}$	MEPC. 364(79)	2.2.8.4	V_{ref}	$P_{ME}= f(MCR_{lim})$	$P_{ME}= f(MCR_{lim})$	$P_{ME}= f(MCR_{lim})$

Notes:

1 calculation following Resolution MEPC.350(78)
2 calculation following Resolution MEPC. 364(79) by replacing MCR with MCR_{lim}
3 calculation following Resolution MEPC. 364(79), Paragraph 2.2.5.2, option 2.

For LNG carriers having diesel electric, steam turbine or dual fuel (engine) conventional propulsion systems, guidelines for the calculation of the Attained EEXI are respectively in paragraphs 6.3, 7.3, 7.6 and 7.7 of IACS Rec. No. 172, taking into account the combustion of excessive natural boil-off gas in the engines or boilers, to avoid releasing to the atmosphere or unnecessary thermal oxidation (paragraph 7.2 of IACS Rec. No. 172).

On ships with shaft generator(s) installed, **without** Shaft or Engine Power Limitation, $P_{ME(i)}$ is to be calculated as follows:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 * \left(\sum_{i=1}^{n} MCR_{ME(i)} - \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)}\right)$$

with: $\sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} \leq P_{AE}/0.75$

On ships with shaft generator(s) installed, **with** Shaft or Engine Power Limitation, $P_{ME(i)}$ is to be calculated as follows:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 * \left(\sum_{i=1}^{n} MCR_{lim(i)} - \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)}\right)$$

with: $\sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} \leq P_{AE}/0.75$

If in this case a ShaPoLi is applied on the shaft between coupling out for electric power (reduction gear, shaft generator) and propeller, the power limit of the ShaPoLi is reduced by PPTO, the power of the shaft generator which is available without limitation. This means that the power limit of the ShaPoLi is $MCR_{lim} – P_{PTO}$ and accordingly P_{ME} is 75% of the power limit of the ShaPoLi.

Care is to be taken to the fact that the ship speed V_{ref} is to be obtained from the speed-power curve using the value of P_{ME} as above, and not 75% of MCR_{ME}.

4.3 $C_{FME(i)}$ and C_{FAE}

$C_{FME(i)}$ and C_{FAE} are non-dimensional conversion factor between fuel consumption measured in g and CO_2 emission also measured in g based on carbon content.
The values of both $C_{FME(i)}$ and C_{FAE} are to be taken from Table 4, by using the C_F value on the line corresponding to the fuel used when determining *SFC*, as listed in the applicable test report included in a NO_X Technical File.

Table 4

Type of fuel	Reference	Lower calorific value (kJ/kg)	Carbon content	C_F
1 Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	42700	0.8744	3.206
2 Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41200	0.8594	3.151
3 Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40200	0.8493	3.114
4 Liquified petroleum gas (LPG)	Propane	46300	0.8182	3.000
	Butane	45700	0.8264	3.030
5 Liquefied Natural Gas (LNG)		48000	0.7500	2.75
6 Methanol		19900	0.3750	1.375
7 Ethanol		26800	0.5217	1.913

The fuel used when determining corrected SFC corresponds to the value of the CF conversion factor, according to the table provided under paragraph “CF ; Conversion factor between fuel consumption and CO_2 emission” of the IMO EEDI Calculation Guidelines(Resolution MEPC.364(79), as amended).

- In case SFC is corrected to ISO standard reference conditions with standard LCV of LFO (41,200 kJ/kg), SFC and the conversion factor, Cf (3.151), are to correspond to LFO.
- In case SFC is corrected to ISO standard reference conditions with standard LCV of MDO (42,700kJ/kg), SFC and the conversion factor, Cf (3.206), are to correspond to MDO.

For those engines which do not have a test report included in the NO_X Technical File, the value corresponding to the fuel used by the manufacturer to determine the SFC is to be used.
For those engines which do not have a NO_X Technical File with a test report included, and which do not have the *SFC* specified by the manufacturer, the value of:

3.114 $[t_{Co2}/t_{fuel}]$

is to be used for $C_{F,}$ including the case when HFO is used in practice, along with the value of SFC_{app} per [4.4].

In case of a ship equipped with dual-fuel main or auxiliary engine, gas fuel should be identified whether it is regarded as the "primary fuel by means of evaluation of the parameter f_{DFgas}, to be calculated according to paragraph 2.2.1 of Resolution MEPC.364(79).

Two cases may occur:

1. $f_{DFgas} \geq 0.5$,
   then gas fuel is regarded as the "primary fuel".
   In this case the factor: "$P_{ME(i)} * C_{FME(i)} * SFC_{ME(i)}$"
   in the EEXI formula is to be replaced by:
   "$P_{ME(i)} * (C_{FME\ pilot\ fuel(i)} * SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} * SFC_{ME\ gas(i)})$"
   The same modification applies to the factor "$P_{AE} * C_{FAE} * SFC_{AE}$" for dual fuel auxiliary engines.

2. $f_{DFgas} < 0.5$
   then gas fuel is not regarded as the "primary fuel."
   In this case the factor: "$P_{ME(i)} * C_{FME(i)} * SFC_{ME(i)}$"
   in the EEXI formula is to be replaced by:
   "$P_{ME(i)} * [f_{DFgas(i)} * (C_{FME\ pilot\ fuel(i)} * SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} * SFC_{ME\ gas(i)}) + f_{DFliquid(i)} * C_{FME\ liquid(i)} * SFC_{ME\ liquid(i)}]$"

The primary fuel of LNG Carriers with dual fuel engines (using cargo as fuel) is gas by default.

4.4 $SFC_{ME(I)}$ and SFC_{AE}

$SFC_{ME(I)}$ and SFC_{AE} are the main/auxiliary engine Specific Fuel Consumptions as recorded for the parent engine in the test report included in a NO_X technical file:

- for main engines certified to the E2 or E3 test cycles, is the *SFC* at 75% of MCR power;
- for auxiliary engines certified to the D2 or C1 test cycles, is the *SFC* at 50% of MCR;
- if gas fuel is used as primary fuel, the *SFC* in gas mode is to be used. In case that installed engines have no approved NO_X Technical File tested in gas mode, the *SFC* of gas mode should be submitted by the manufacturer and confirmed by the verifier.

In case different values of *SFC* are available from multiple sources, the hierarchy of data shown in Table 5 is to be taken into account.

Table 5: SFC value to be used in the EEXI calculations

Options	1	2	3	4
	Parent Engine ISO corrected is available	Member engine ISO corrected is available	Parent Engine not ISO corrected is available but corrected as best as possible based on available data (e.g. *LCV*)	Member engine not ISO corrected is available but corrected as best as possible based on available data (e.g. *LCV*)
Pre-EEDI ship with power limitation	Acceptable	Acceptable	Acceptable	Acceptable
Pre-EEDI ship without power limitation	To be used	Acceptable only in case Option 1 is not available	Acceptable	Acceptable
EEDI ship with power limitation	Acceptable	Acceptable	Acceptable	Acceptable
EEDI ship without power limitation	*SFC* value stated in EEDI TF to be used			

Not ISO-corrected values are acceptable only in case ISO corrected values are not available.

Retrofitted exhaust gas scrubber systems are not considered to affect the EEXI calculations in terms of *SFC*.

In case the engine is retrofitted with a new type of fuel nozzles or optimization of fuel injection, the new *SFC* specified by the main engine designer is acceptable, provided the approved NO_x Technical File of the engine is amended accordingly.

The *SFC* as reported in the test report included on the NO_X Technical File is to be corrected to the standard lower heat value (LHV) of the fuel oil, referring to ISO 15550:2002 and ISO 3046-1:2002.

In case of power limitation:

- In case where the main engine designer is involved, the main engine designer to provide *SFC* at new P_{ME}, based on interpolation from test bed measurements ISO corrected and this is to be shown in the main engine designer's power limitation report. The *SFC* value at P_{ME} to be used in the EEXI calculation is to be to the satisfaction of the Verifier.
- In case the main engine designer is not involved, the *SFC* value at P_{ME} to be used in the EEXI calculation to be confirmed by the Verifier.

Notwithstanding the above, the *SFC* specified by the manufacturer or confirmed by the Verifier may be used.

For those engines which do not have a NO_X Technical File with a test report included, and which do not have the *SFC* specified by the manufacturer or confirmed by the Verifier, the *SFC* can be approximated by SFC_{app} defined as follows:

$SFC_{ME,app} = 190\ [g/kWh]$

$SFC_{AE,app} = 215\ [g/kWh]$

For ships equipped with steam turbine (note that, being a non-conventional propulsion, among ships equipped with steam turbine, only cruise ships and LNG carriers are subject to EEXI), the $SFC_{SteamTurbine}$ should be calculated by manufacturer and verified by the Administration or an organization recognized by the Administration, as follows:

$$SFC_{SteamTurbine} = \frac{Fuel\ Consumption}{\sum_{i=1}^{nME} P_{ME_{(i)}}}$$

For ships whose electric power is primarily supplied by a turbine generator closely integrated into the steam and feed water systems, electric loads (P_{AE}) should either be assumed as 0 (zero) in calculating the EEXI or added to P_{ME}, as follows:

$$SFC_{SteamTurbine} = \frac{Fuel\ Consumption}{\sum_{i=1}^{nME} P_{ME_{(i)}} + P_{AE}}$$

where:

1 Fuel consumption is fuel consumption of boiler per hour (g/h).
2 The *SFC* should be corrected to the value of LNG using the standard lower calorific value of the LNG (48,000 kJ/kg) at SNAME Condition (condition standard; air temperature 24°C, inlet temperature of fan 38°C, sea water temperature 24°C).
3 In this correction, the difference of the boiler efficiency based on lower calorific value between test fuel and LNG should be taken into account.

In case of unavailability of the value of $SFC_{SteamTurbine}$ calculated by manufacturer and verified as above, the value may be obtained from onboard measurements at 83% MCR, to be carried out under survey.

Regarding the Specific Gas Consumption (*SGC*) calculation for the steam-turbine LNGs, in most cases the specific gas consumption at varying loads is not available in the Steam Heat Balance & Flow Diagram drawing. In case the gas consumption is available at the Steam Heat Balance & Flow Diagram drawing (3 or more load points), then these values are to be used.

The Fuel Oil Consumption (FOC) is to be corrected to the value of LNG as per paragraph 2.2.7.2.2 of Resolution MEPC.364(79). The FOC should be multiplied with the ratio of the lower calorific values (*LCV*) of the respective Fuel oil and LNG.

The conversion of SFOC to *SGC*, is taken as follows:

$$SFOC \cdot \left(\frac{LCV_{(Fuel\ Oil)}}{LCV_{(LNG)}}\right)$$

Anyway, in case different values of *SFC* are available from multiple sources, the following hierarchy of data (in order of decreasing precedence) is to be taken into account:

1. *SFC* from Parent engine test report included in the NO_x Technical File
2. *SFC* from Member engine test report included in the NO_x Technical File
3. *SFC* measured on board in g/h and converted to g/kWh (only in case of derating with engine modifications)
4. *SFC* from Member engine test report included in the NO_x Technical File of another engine of the same type
5. *SFC* from individual engine test report
6. *SFC* declared by manufacturer
7. *SFC* measured on board in g/h and converted to g/kWh (except in case of derating with engine modifications).

In case two or more sets of SFC measurement results at the same rating are submitted to the verifier for the various loads of the same engine, the average SFC is to be used.

4.5 P_{AE}

P_{AE} is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery/systems and accommodation, in the condition where the ship is engaged in voyage at the speed (V_{ref}) at summer load draught.
It includes main engine pumps, navigational systems and equipment and living on board, but excluding the power not for propulsion machinery/systems, e.g. thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, e.g. reefers and cargo hold fans.

$P_{AE(i)}$ is calculated in accordance with paragraph 2.2.5.6 of Resolution MEPC.364(79) as follows:

- For ships which total propulsion power $\left(\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75}\right)$ is 10,000 kW or above, P_{AE} is defined as:

$$P_{AE\ (\sum MCR_{ME} \geq 10000\ kw)} = \left(0.025 * \left(\sum_{1=1}^{nME} MCR_{ME(i)} + \frac{\sum_{i=1}^{nPTI} P_{PTI(i)}}{0.75}\right)\right) + 250$$

- For ships which total propulsion power is below 10,000 kW, P_{AE} is defined as:

$$P_{AE\ (\sum MCR_{ME} < 10000\ kw)} = \left(0.05 * \left(\sum_{1=1}^{nME} MCR_{ME(i)} + \frac{\sum_{i=1}^{nPTI} P_{PTI(i)}}{0.75}\right)\right)$$

- In case of overridable power limitation, P_{AE} is to be based on the original MCR.
- In non-overridable power limitation cases listed in Table 3 in [4.2] of this Guide, P_{AE} is to be based on MCR_{lim}.
- For ships having shaft generator(s), part of the normal maximum sea load is provided by shaft generators and in this case, the term:

$$(P_{AE} * C_{FAE} * SFC_{AE})$$

  is to be replaced by:

$$\left(P_{AE} - 0.75 * \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)}\right) * C_{FAE} * SFC_{AE} + 0.75 * \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} * C_{FME} * SFC_{ME}$$

  with the term $\left(P_{AE} - 0.75 * \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)}\right)$ to be considered as zero (0) when $0.75 * \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} > P_{AE}$
- For LNG carriers with a reliquefaction system or compressor(s), used for supplying gas derived from boil-off gas to the installed engines, additional terms, calculated according to paragraph 2.2.5.6.3 of Resolution MEPC. 364(79) are to be added to above P_{AE} formula. $BOG_{reliquefy}$ and density of BOG are to be derived from the ship's technical specification. Reliquefaction plants are to be considered according to paragraph 2.2.5.6.3 of Resolution MEPC.364(79) except when the full amount of BOG can be used for propulsion or auxiliary engines.
- For ships where the value of P_{AE} - calculated in accordance with paragraphs 2.2.5.6.1 to 2.2.5.6.3 of Resolution MEPC.364(79) - is significantly different from the total power used at normal seagoing (e.g. in case of passenger ships), the P_{AE} value should be estimated by the consumed 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, divided by the average efficiency of the generator(s) weighted by power (see Appendix 2 of Resolution MEPC.364(79)).
  In case where the electric power table is not available, the P_{AE} value may be approximated either by:
  a) annual average figure of P_{AE} at sea from onboard monitoring obtained prior to the EEXI certification;
  b) for cruise passenger ships, approximated value of power of auxiliary engines ($P_{AE,app}$), as defined below:
  $P_{AE,app} = 0.1193 \times \mathrm{GT} + 1814.4$ [kW]
  c) for ro-ro passenger ships, approximated value of power of auxiliary engines ($P_{AE,app}$), as defined below:
  $P_{AE,app} = 0.866 \times GT^{0.732}$ [kW]

In case different values of P_{AE} are available from multiple sources, the following hierarchy of data (in order of decreasing precedence) is to be taken into account:

.1 annual average figure from monitoring
.2 power tables
.3 value from formula in paragraphs 2.2.5.6.1 to 2.2.5.6.3 of Resolution MEPC.364(79).

The annual average figure from monitoring is preferably to be obtained from an automatic continuous monitoring system, but in cases where this is not possible, Tasneef may accept the average figure resulting from manual monitoring and recording subject to:

- monitoring is carried out for at least one period in summer conditions and one in winter conditions, both with the ship fully operational; if a period of monitoring in summer conditions cannot be carried out before the required date of verification of the attained EEXI, the complement to 50% of the nominal power of the air conditioning compressors will be added to the average measured power;
- the observation windows are of at least 14 days for each seasonal period (summer/winter);
- the interval between the readings is not exceeding 8 hours.

The individual records (with date and time) and calculated average are to be formally communicated by the company and their consistency is to be validated by Tasneef through surveys or remote inspections (in the case of Passenger ships, a survey or remote inspection for each observation window).

Suggestions

In case of unavailability of power tables, or modifications introduced to reduce the electric power consumption:

- a purpose revised power table may be drafted, excluding the power not for propulsion machinery/systems, e.g. thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, e.g. reefers and cargo hold fans, and also taking into account the possible improvements put in place to reduce the electrical power consumption (e.g. frequency converters, LED lights, Waste heat recovery systems);
- the revised power table is to be validated by either a survey on board (possibly remote) or by reviewing the data recorded in data loggers, when fitted;
- the revised and validated power table is to be submitted for approval.

It is often convenient to include in the calculation the effect of shaft generators because the specific fuel consumption of main engines (typically 180 g/kWh) is normally lower than the one of the auxiliary engines (typically 200 g/kWh).

For example, for a P_{AE} of 1200 kW it results in: 1200*3.206*200 = 769,440
However, with a shaft generator of 800 kW, it results in:
$(1200 * 3.206 * 200(1200 - 0.75 * 0.75 * 800) * 3.206 * 200 + 0.75 * 0.75 * 800 * 3.206 * 180 = 740586$ => -3.75%

In this case, care is to be taken to the fact that the ship speed V_{ref} is to be obtained from the speed-power curve using the value of power obtained from equation:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 * \left(\sum_{i=1}^{n} MCR_{ME(i)} - \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} \right)$$

In case shaft generator(s) are installed in a propulsion system driven by a steam turbine, $P_{PTO(i)}$ is 83% of the rated electrical output power and the factors 0.75 in the above formula should be changed into 0.83.

Warning

There may be cases, namely ro-ro cargo and ro-ro passenger ships applying the correction factor F_{jroro} based on V_{ref} (see [4.8]), where the accounting of shaft generators may be penalizing in term of EEXI.

4.6 P_{PTI}

The term P_{PTI} represents the power consumption of shaft motors, including the power of propulsion motors of ships with diesel electric propulsion (presently, among ships with non-conventional propulsion, only Cruise and LNG carriers are subject to EEXI requirements). For LNG carriers with diesel electric propulsion refer to [4.2] since the electric motor power is to be accounted as P_{ME} and not P_{PTI}.

In case where shaft motor(s) are installed, $P_{PTI(i)}$ is 75% of the rated power consumption of each shaft motor (i.e. its rated power output divided by its efficiency $\eta_{PTI(i)}$) divided by the weighted average efficiency of the generator(s), as follows:

$$\sum P_{PTI(i)} = \frac{\sum_{i=1}^{n}\left(0.75 * P_{SM,\max(i)}\right)}{\eta_{Gen}} = \frac{\sum_{i=1}^{n}\left(0.75 * \frac{P_{out,rated(i)}}{\eta_{PTI(i)}}\right)}{\eta_{Gen}}$$

where:

$P_{SM,max(i)}$ is the rated power consumption of each shaft motor;
$P_{out,rated(i)}$ is the rated power output of each shaft motor;
η_{Gen} is the weighted average efficiency of the generator(s);
$\eta_{PTI(i)}$ is the efficiency of each shaft motor installed.

In this case the ship speed, V_{ref}, is to be obtained from the speed-power curve using the value of propulsion power obtained from equation:

$$\sum_{i=1}^{n} P_{ME(i)} + \sum_{i=1}^{nPTO} P_{PTI(i)} = 0.75 * \left(\sum_{i=1}^{n} MCR_{ME(i)} + \sum_{i=1}^{nPTI} P_{out,rated(i)}\right)$$

For cruise ships with diesel electric propulsion, in case of power limitation P_{PTI} is calculated as follows in line with paragraph 6.2 of IACS Rec. No. 172:

$$\sum P_{PTI(i)} = \frac{\sum_{i=1}^{n}\left(0.75 * \frac{P_{out,lim(i)}}{\eta_{PTI(i)}}\right)}{\eta_{Gen}}$$

4.7 Capacity

For bulk carriers, tankers, gas carriers, LNG carriers, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships, ro-ro passenger ships, general cargo ships, refrigerated cargo carrier and combination carriers, deadweight (as documented in the approved stability information or loading manual) should be used as capacity.

For passenger ships and cruise passenger ships, gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, Annex I, Regulation 3, as documented in the International Tonnage Certificate, should be used as capacity.

In case of a ship with multiple load line certificates or with a load line certificate containing multiple summer load lines, the EEXI calculation is to be performed using the deadweight at maximum (summer) draught as documented in the IEEC Supplement. The Flag Administration is to advise whether the remaining Load Line certificates need to be assessed.

For containerships, 70% of the deadweight (*DWT*) should be used as capacity.

When deadweight (*DWT*) is used as capacity, it is to be calculated as the difference in tonnes between the displacement of a ship in water of relative density of 1025 kg/m^3 at the summer load draught and the lightweight of the ship. The summer load draught should be taken as the maximum summer draught as certified in the approved stability booklet.

$$DWT = \Delta_{summer}[m^3] * 1.025 - lightship$$

4.8 V_{ref}

V_{ref} is defined as the ship speed, (in knots), at the propulsion power P_{ME} as defined in [4.2], on deep water and assuming the weather is calm with no wind and no waves in the condition corresponding to:

- the summer load line draught for all ships except containerships
- 70% of the *DWT* for containership

Care is to be taken in case shaft generators are fitted, that the ship speed V_{ref} is obtained from the speed-power curve using the value of power from the following equation:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 * \left(\sum_{i=1}^{n} MCR_{ME(i)} - \sum_{i=1}^{nPTO} 0.75 * MCR_{PTO(i)} \right)$$

1) For ships falling into the scope of the EEDI requirement, the ship speed V_{ref} should be obtained from an approved speed-power curve as defined in Resolution MEPC.254(67), as amended by Resolution MEPC.261(68) and Resolution MEPC.309(73).

2) For ships not falling into the scope of the EEDI requirement but whose sea trials have been carried out under a draught other than the EEDI one and whose sea trial results are included in the sea trial report (which may have been calibrated by the tank test), there are three different options to transfer a known speed/power curve from a specific draught to the EEXI draught:
   1. Model tests/ CFD calculation: Curves are determined for both draughts, so that the relation is known.
   2. Admiralty equation: This well-known, experience-based method is based on the relation of the displacement of both draughts.
   3. The formula in paragraph 2.2.3.4 of Resolution MEPC.350(78): A factor is calculated from the relation of the deadweight of both draughts (for bulk carries, tankers and container ships only).

   Only model tests or CFD calculations can be applied for the transfer from trimmed ballast draught to the EEXI draught. Admiralty equation and the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) can only be used for the transfer from design or service draught on even keel to EEXI draught.

   The Admiralty equation is a well-known formula for estimation of required power *P* depending on displacement ∆ and ship speed *V*:

$$P = const \cdot \Delta^{\frac{2}{3}} \cdot V^3$$

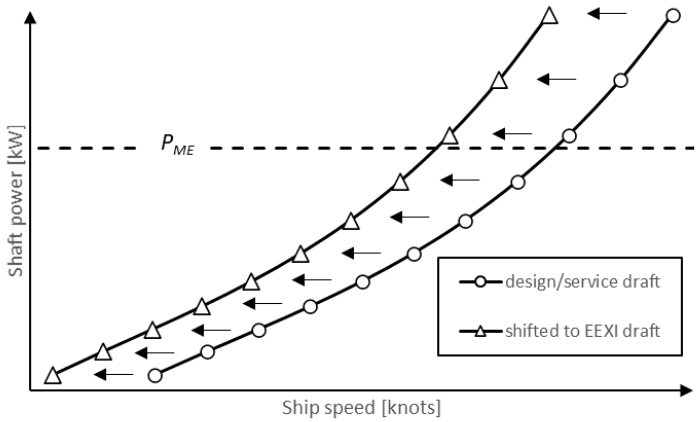
   This relation can be applied to calculate the influence of different draft on power and ship speed.

   Although paragraph 2.2.3.4 of Resolution MEPC.350(78) refers to the service power point only, the speed/power curve in design load draught should be considered for the transfer to the EEXI draught following the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78).

   Applying the actual speed/power curve from model tests or sea trials gives more accurate results than applying the cubic law as included in Admiralty equation and in the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) for the transfer from service speed power to P_{ME}.

   The whole speed/power curve is shifted along the x-axis (speed) by multiplying each speed point with the constant factor calculated from Admiralty equation or the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) as given in Figure 1 and the next paragraphs.

Figure 1: shift of design/service draught model test curve to EEXI draught



   Only if no curve is given in the report, then a cubic curve is drawn through the given point, transferred to EEXI draught and then the speed for the EEXI relevant power can be taken from this curve.

The minimum requirement for a pre-EEDI sea trial report is that double runs were performed, and the results of the single runs can be identified.
For Pre-EEDI ships, the sea trial analysis report at the time of delivery, can be considered as valid supporting documentation for the EEXI calculation, even if the speed-power curve is uncorrected for weather conditions. In such case, a re-evaluation of sea trial report with regard to weather conditions is not acceptable. If the sea trial analysis report contains the speed-power curve from model tests, the V_{ref} derived from this curve would be acceptable.

In case the ship has a model tests report and a sea trials report based on ISO 15016:2002 or equivalent, then the EEXI calculation can be based on a speed-power curve from either the model tests report or the sea trial report.

2.1) For **ships (other than bulk carriers, tankers and container ships)** not falling into the scope of the EEDI requirement but whose sea trial results, which may have been calibrated by the tank test, under EEDI draught and the sea trial condition as specified above are included in the sea trial report, the ship speed V_{ref} may be obtained from the sea trial report as:

$$V_{ref} = V_{S,EEDI} \times \left[\frac{P_{ME}}{P_{S,EEDI}}\right]^{\frac{1}{3}} \quad [\text{knot}]$$

where:
$V_{S,EEDI}$ is the sea trial service speed under the EEDI draught; and
$P_{S,EEDI}$ is power of the main engine corresponding to $V_{S,EEDI}$

If the speed-power curve at design load draught (service) is available, at this draught the speed V_d is derived at the P_{ME}. Subsequently, the V_{ref} at EEXI draught is calculated based on the formula below:

$$V_{ref} = \left(\frac{\Delta_{s,service}}{\Delta_{EEXI}}\right)^{\frac{2}{9}} * V_d$$

V_{ref} to be within the performance margin m_V of V_d , which should be 5% of V_d or one knot, whichever is lower.
In case $(V_d - V_{ref}) > m_v$, then the Admiralty equation is not to be applied, instead $V_{ref,app}$ to be used.

If the speed-power curve at design load draft (service) is not available and only one service point is available ($P_{s,service}$, $V_{s,service}$). The V_{ref} at EEXI draft is calculated based on the formula below:

$$V_{ref} = \left(\frac{\Delta_{s,service}}{\Delta_{EEXI}}\right)^{\frac{2}{9}} * V_{s,service} * \left(\frac{P_{ME}}{P_{s,service}}\right)^{\frac{1}{3}}$$

V_{ref} to be within the performance margin m_V of $V_{s,service} * \left(\frac{P_{ME}}{P_{s,service}}\right)^{\frac{1}{3}}$ which should be 5% of the above or one knot, whichever is lower.

When $(V_{s,service} * \left(\frac{P_{ME}}{P_{s,service}}\right)^{\frac{1}{3}} - V_{ref}) > m_v$, then the Admiralty equation is not to be applied, instead $V_{ref,app}$ to be used.

2.2) For **bulk carriers and tankers**, the Admiralty equation is not to be applied. The formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) with scale coefficient *k* can be applied to transfer the speed-power curve from a draught that is below the maximum summer load draught. The term *DWT* for *k* factor definition refers to the *DWT* at the summer load draught (and not the $DWT_{s,service}$).

In case the curve at design load draught (service) is available, the speed V_d is derived at the P_{ME}. Subsequently, the V_{ref} at EEXI draught is calculated based on the formula below:

$$V_{ref} = k^{\frac{1}{3}} * \left(\frac{DWT_{s,service}}{Capacity}\right)^{\frac{2}{9}} * V_d$$

In case the curve at design load draught (service) is not available and only one service point is available ($P_{s,service}$, $V_{s,service}$), then the V_{ref} at EEXI draught is calculated based on the formula below:

$$V_{ref} = k^{\frac{1}{3}} \times \left(\frac{DWT_{S,service}}{Capacity}\right)^{\frac{2}{9}} \times V_{S,service} \times \left[\frac{P_{ME}}{P_{S,service}}\right]^{\frac{1}{3}} \quad [\text{knot}]$$

$V_{S,service}$ is the sea trial service speed under the design draught
$DWT_{S,service}$ is the deadweight under the design draught
$P_{S,service}$ is the power of the main engine corresponding to $V_{S,service}$
k is the scale coefficient, which should be:

- 0.97 for bulk carrier with 200,000 DWT or less;
- 1.00 for bulk carrier with more than 200,000 DWT;
- 0.97 for tanker with 100,000 DWT or less; and
- 1.00 for tanker with more than 100,000 DWT.

The service draught is to be on even keel. The formula cannot be applied for a trimmed draught.

If more than one speed-power curve is available for a loaded draught on even keel (e.g. design draught and scantling draught before deadweight increase), the curve of the draught that is closer to EEXI draught is to be applied for the transfer to EEXI draught. The even keel definition to be taken as the one described at the sea trial analysis ISO standard applicable at the time.

2.3) For **container ships**, the Admiralty equation is not to be applied. The formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) with scale coefficient *k* can be applied to transfer the speed-power curve from a draught that is different from the EEXI draught. For container ships this different draught might be larger or smaller than the EEXI draught which is defined by *70% DWT*.

Service draught to be on even keel. There is no limitation for the relation of the DWT for both draughts, but trimmed conditions cannot be accepted.

If more than one speed-power curve is available for a loaded draught on even keel (e.g. design and scantling draught), the curve of the draught that is closer to EEXI draught is to be applied for the transfer to EEXI draught.

V_{ref} at EEXI draught is calculated based on the containership size as per Table 6 where:

- the term *DWT* refers to the DWT at the summer load draught (and not the $DWT_{s,service}$) and
- the term *Capacity* refers to paragraph 2.2.3 of Resolution MEPC.364(79).

Table 6

Container ship size applicability	**Derivation of V_{ref}**
Where: *($DWT_{s,service}$ / Capacity)* **<** *1.0* or where: *DWT* **≤** *120,000 tonnes* and *($DWT_{s,service}$ / Capacity)* **>** *1.08* or where: *DWT* **>** 120,000 tonnes and *($DWT_{s,service}$ / Capacity)* **>** *1.12*	In case the curve at service draught is available, the speed V_d is derived at the P_{ME}. Subsequently, the V_{ref} at EEXI draught is calculated based on the formula below: $$V_{ref} = k^{\frac{1}{3}} * \left(\frac{DWT_{s,service}}{Capacity}\right)^{\frac{2}{9}} * V_d$$ In case the curve at service draught is not available and only one service point is available ($P_{s,service}$, $V_{s,service}$), then the V_{ref} at EEXI draught is calculated based on the formula below: $$V_{ref} = k^{\frac{1}{3}} * \left(\frac{DWT_{s,service}}{Capacity}\right)^{\frac{2}{9}} * V_{s,service} * \left(\frac{P_{ME}}{P_{s,service}}\right)^{\frac{1}{3}}$$
Where: *DWT > 120,000 tonnes* and *1.0 < ($DWT_{s,service}$ / Capacity)* **≤** *1.12*	*Vref* to be derived from the available curve at P_{ME}.
Where: *DWT* **≤** *120000 tonnes* and *1.0 < ($DWT_{s,service}$ / Capacity)* **≤** *1.08*	*Vref* to be derived from the available curve at P_{ME}.

where:

$V_{S,service}$ is the sea trial service speed under the design draught;
$DWT_{S,service}$ is the deadweight under the design draught;

$P_{S,service}$ is the power of the main engine corresponding to $V_{S,service}$;
k is the scale coefficient, which should be:

- 0.95 for containerships with 120,000 DWT of less
- 0.93 for containerships with more than 120,000 DWT

3) For ships not falling into the scope of the EEDI requirement for which the speed-power curve is not available or the sea trial report does not contain the EEDI or design load draught condition, the ship speed V_{ref} can be either:

3.1) obtained from the in-service performance measurement method conducted and verified in accordance with the methods and procedures as specified in MEPC.1/Circ.901; or

3.2) approximated by $V_{ref,app}$ obtained from statistical mean of distribution of ship speed and engine power, as defined below:

$$V_{ref,app} = \left(V_{ref,avg} - m_V\right) \times \left[\frac{\sum P_{ME}}{0.75 * MCR_{avg}}\right]^{\frac{1}{3}} \quad [\text{knot}]$$

For LNG carriers having diesel electric propulsion system and cruise passenger ship having non-conventional propulsion:

$$V_{ref,app} = \left(V_{ref,avg} - m_V\right) \times \left[\frac{\sum MPP_{Motor}}{MPP_{avg}}\right]^{\frac{1}{3}} \quad [\text{knot}]$$

where:
$V_{ref,avg}$ is a statistical mean of distribution of ship speed in given ship type and ship size, to be calculated as follows: $V_{ref,avg} = A \times B^C$
A, B and C are the parameters given in Table 7 below.

Table 7: Parameters to calculate $V_{ref,app}$

Ship type	A	B	C
Bulk carrier	10.6585	DWT of the ship	0.02706
Gas carrier	7.4462	DWT of the ship	0.07604
Tanker	8.1358	DWT of the ship	0.05383
Containership	3.2395	- DWT of the ship where DWT ≤ 80,000 - 80,000 where DWT > 80,000	0.18294
General cargo ship	2.4538	DWT of the ship	0.18832
Refrigerated cargo carrier	1.0600	DWT of the ship	0.31518
Combination carrier	8.1391	DWT of the ship	0.05378
LNG carrier	11.0536	DWT of the ship	0.05030
Ro-ro cargo ship (vehicle carrier)	16.6773	DWT of the ship	0.01802
Ro-ro cargo ship	8.0793	DWT of the ship	0.09123
Ro-ro passenger ship	4.1140	DWT of the ship	0.19863
Cruise passenger ship having non-conventional propulsion	5.1240	GT of the ship	0.12714

m_V is a performance margin of a ship, which should be 5% of $V_{ref,avg}$ or 1 [knot], whichever is lower;
MPP_{Motor} is rated output of motor; and
MCR_{avg} is a statistical mean of distribution of MCRs for main engines and MPP_{avg} is a statistical mean of distribution of MPPs for motors in given ship type and ship size, to be calculated as:

$$MCR_{avg} or\ MPP_{avg} = D \times E^F$$

where D, E and F are the parameters given in Table 8.

Table 8: Parameters to calculate MCR_{avg} or MPP_{avg} (= D x E^F)

Ship type	D	E	F
Bulk carrier	23.7510	DWT of the ship	0.54087
Gas carrier	21.4704	DWT of the ship	0.59522
Tanker	22.8415	DWT of the ship	0.55826
Containership	0.5042	- DWT of the ship where DWT ≤ 95,000 - 95,000 where DWT > 95,000	1.03046
General cargo ship	0.8816	DWT of the ship	0.92050
Refrigerated cargo carrier	0.0272	DWT of the ship	1.38634
Combination carrier	22.8536	DWT of the ship	0.55820
LNG carrier	20.7096	DWT of the ship	0.63477
Ro-ro cargo ship (vehicle carrier)	262.7693	DWT of the ship	0.39973
Ro-ro cargo ship	37.7708	DWT of the ship	0.63450
Ro-ro passenger ship	9.1338	DWT of the ship	0.91116
Cruise passenger ship having non-conventional propulsion	1.3550	GT of the ship	0.88664

In case where an overridable Shaft/Engine Power Limitation is installed, the ship speed V_{ref} approximated by $V_{ref,app}$ should be calculated as follows:

$$V_{ref,app} = \left(V_{ref,avg} - m_V\right) \times \left[\frac{\sum P_{ME}}{0.75 * MCR_{avg}}\right]^{\frac{1}{3}}$$

It is reminded, in this context, that P_{ME} is 83 % of the limited installed power (MCR_{lim}) or 75% of the original installed power (MCR), whichever is lower, deducted of 75% of the shaft generator power, as given in [4.2].

For LNG carriers having diesel electric propulsion system and cruise passenger ship having non-conventional propulsion:

$$V_{ref,app} = \left(V_{ref,avg} - m_V\right) \times \left[\frac{\sum MPP_{lim}}{MPP_{avg}}\right]^{\frac{1}{3}}$$

For LNG carriers having steam-turbine propulsion:

$$V_{ref\ ,app} = \left(V_{ref\ ,avg} - m_V\right) \cdot \left[\frac{\sum MCR_{SteamTurbine}}{MCR_{avg}}\right]^{\frac{1}{3}}$$

For steam turbine LNG carriers with power limitation:

$$V_{ref\ ,app} = \left(V_{ref\ ,avg} - m_V\right) \cdot \left[\frac{\sum MCR_{lim}}{MCR_{avg}}\right]^{\frac{1}{3}}$$

Propulsion Improvement Device (PID)

In all the cases under 1) to 3) above, when any PID is installed that shifts the power curve, which results in the change of propulsion power P_P and V_{ref}, as specified in MEPC.1/Circ.896, the effect of the device may be reflected in the ship speed V_{ref} with the approval of the verifier, based on following methods in accordance with defined quality and technical standards:

.1 sea trials after installation of the device, and/or
2 in-service performance measurement method (MEPC.1/Circ.901); and/or
.3 dedicated model tests; and/or
.4 numerical calculations.

In this case, the EEXI Technical File is to include an addendum with the validation of the performance data and the methodology for the assessment of the efficiency improvements is to be previously agreed with Tasneef.

In case of lower friction hull coatings, which are considered an Energy Efficiency Technology in Category A as per MEPC.1/Circ 896, the V_{ref} may be determined as follows:

- for both pre-EEDI and EEDI ships by new sea trials which, if carried out at a draft other than EEXI draft, may be calibrated by the original model test or CFD without the effect of low friction coating
- for pre-EEDI ships by:
  - re-evaluation of model test or
  - model scale CFD calculation or

- model test supplemented with CFD calculation following the requirements in the Annex of this document without any calibration by sea trials provided that the CFD are based on IACS Rec 173. In case of CFD, the new average hull roughness is not to be taken into account directly in the numerical simulations.

The requirements for the derivation of reference speed (Vref) exclusively in the framework of the EEXI are contained in the Annex of IACS Rec. 172 Rev.1

In a case of identical PIDs retrofitted on sister ships, the percentage of power savings verified (by either sea trials, or model tests, or numerical analysis, as applicable) for one ship of the series can be applied to the sister ships. A ship is considered a sister ship if built in a series by same shipyard with identical main dimensions, body lines, appendages, and propulsion system.

In case of retrofitted PID where comparative model tests have been carried out, the V_{ref} derived from the processes described in Table 9 will be acceptable. Other processes where the propulsion power savings from comparative model tests are applied for the derivation of V_{ref}, may be acceptable to Verifier. For instance, the original speed-power curve (when available), can be applied instead of a cubic curve approach.

Table 9

Case No	Available information	Process to be followed where applicable (see note)
1a	- Original sea trial design draft without PID - Comparative model tests EEXI draft with and without PID	- Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the k scale factor to original sea trial design draft without PID ➔ speed-power curve at EEXI draft without PID - Comparative model tests EEXI draft with and without PID ➔ power savings percentages at different speeds - At these speeds, the estimated power curve at EEXI draft with PID is calibrated
1b	- Original sea trial design draft without PID - Comparative model tests EEXI draft with and without PID	- Comparative model tests EEXI draft with and without PID ➔ power savings percentages at different speeds - At these speeds, the original sea trial at design draft is calibrated - Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the *k* scale factor
2a	- Original sea trial design draft without PID - Comparative model tests design draft with and without PID	- Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the k scale factor to original sea trial design draft without PID ➔ speed-power curve at EEXI draft without PID - Comparative model tests design draft with and without PID ➔ power savings percentages at different speeds - At these speeds, the estimated power curve at EEXI draft with PID is calibrated
2b	- Original sea trial design draft without PID - Comparative model tests design draft with and without PID	- Comparative model tests design draft with and without PID ➔ power savings percentages at different speeds - At these speeds, the original sea trial at design draft is calibrated - Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the *k* scale factor
3	- Original sea trial with design draft without PID - Comparative model tests with design and EEXI drafts, with and without PID	- Derive deviation between the original sea trial design draft and the comparative model tests design draft WITHOUT PID ➔ power deviation percentage at different speeds - The power deviation percentage is applied to the EEXI draft WITH PID from the comparative model tests
4	- Original sea trial with ballast draft without PID - Comparative model tests with ballast and design drafts, with and without PID	- Derive deviation between the original sea trial ballast draft and the comparative model tests ballast draft WITHOUT PID ➔ power deviation percentage at different speeds - The power deviation percentage is applied to the design draft WITH PID from the comparative model tests - Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the *k* scale factor
5	- Original sea trial with ballast draft without PID - Comparative model tests with ballast and EEXI drafts, with and without PID	- Derive deviation between the original sea trial ballast draft and the comparative model tests ballast draft WITHOUT PID ➔ power deviation percentage at different speeds - The power deviation percentage is applied to the EEXI draft WITH PID from the comparative model tests
6	- No sea trials are available - Comparative model tests at design draft with and without PID	- Apply the model tests results at design draft with PID - Apply the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the *k* scale factor

7	- No sea trials are available - Comparative model tests at EEXI draft, with and without PID	- Apply the model tests results at EEXI draft

Note: for ship types other than bulk carriers, tankers and containerships where the formula in in paragraph 2.2.3.4 of Resolution MEPC.350(78) including the *k* scale factor approach is not applicable, the formula in 2.1) above should be applied.

Propeller trimmed cases

In cases of propeller blade modifications:

- Trailing edge pitch reduction will not be considered as affecting the ship's performance. In other words, the original sea trials will be considered valid for EEXI calculations and supporting documentation.
- Cropping off blades remaining in the cropped condition, will be treated as "new propeller". In such case the original sea trial is no longer valid for EEXI calculation. This infers that as in the case of "new propeller" the Owner is to be required to submit supporting documentation, which could be new model tank tests and/or comparative numerical analysis. Alternatively, the V_{ref} will be based on the $V_{ref,app}$ formula which in most cases results to a lower conservative value.

Change of draught

In cases where there is a change in the EEDI draught (e.g. deadweight increase), the new V_{ref} can be derived as follows:

- Admiralty equation (for all ships except bulk carriers, tankers and container vessels) as described in 2.1)
- $V_{ref,app}$
- V_{ref} as per the formula in paragraph 2.2.3.4 of Resolution MEPC.350(78) (for bulk carriers, tankers and container vessels), extrapolating from design draught to new EEDI draught or from the old EEDI draught to new EEDI draught.

The maximum summer load draught deadweight is to be used, according to paragraph 2.2.4 of Resolution MEPC. 364(79). In absence of the speed power curve at summer load draught, reference can be made to the so-called "scantling draught" speed power curve, which is to be adjusted as per above.

Extrapolation of speed/power curves

In case the final V_{ref} is below or above the range of speeds from the sea trials and/or model tests and/or numerical analysis, an extrapolation of the speed power curve can be used based on power law (power exponent) $e.g. P = a * V^b$.

Note that a change in the ship's summer load line (and hence the deadweight) requires the Required EEXI value to be recalculated.

Availability of different V_{ref} values from multiple sources

Anyway, in case different values of V_{ref} are available from multiple sources, the following hierarchy of data (in order of decreasing precedence) is to be taken into account:

1. V_{ref} from sea trials at EEDI draught, calibrated by model tests or CFD
2. V_{ref} from sea trials at draught other than EEDI draught, calibrated to EEDI draught by model tests or CFD
3. V_{ref} from in-service performance measurement method (MEPC.1/Circ.901)
4. V_{ref} estimated from model tests
5. V_{ref} estimated from CFD
6. V_{ref} adjusted with the Admiralty formula or formulas in 2.2) and 2.3)
7. $V_{ref,app}$

<u>Suggestions</u>

For ships not subject to EEDI and ships which carried out modifications, it is possible to determine V_{ref} by means of dedicated sea trials at conditions corresponding to the Summer load line draught, to develop speed-power curves at EEDI conditions.
The sea trial plan needs to be in accordance with ISO 15016:2015 and submitted to class prior to trials.

The trials are to be witnessed by the verifier and a witnessing statement needs to be issued.

During the sea trials, the sea conditions and ship speed are to be measured in accordance with ITTC Recommended Procedure 7.5-04-01-01.1 “Preparation and Conduct of Speed/Power Trials”; 2017 or ISO 15016:2015.

The results of the sea trials are to be analyzed and corrected according to ISO 15016:2015 or ITTC 7.5-04-01-01.1 “Analysis of Speed/Power Trial Data”, 2017. Software used for the sea trial analysis must be acceptable to the verifier. The sea trial analysis and the verifier’s witnessing statement are to be annexed to the EEXI Technical File as supporting documentation.

Sea trial analysis can be carried out only if relevant data at EEXI draught and sea trial draught are available from model tests and/or numerical calculations. When such data are not available, the in-service performance measurement method (MEPC.1/Circ.901) is applicable.

4.9 Correction factors Fj, Fi, Fc, Fw

The factors F_j, F_i, F_c *and* F_w are to be calculated as per Resolution MEPC.364(79) except that:

- the factor for **ro-ro cargo and ro-ro passenger ships,** f_{jRoRo} is calculated as follows:

$$f_{jRoRo} = \frac{1}{F_{n_L}^{\alpha} \cdot \left(\frac{Lpp}{B_S}\right)^{\beta} \cdot \left(\frac{B_S}{d_S}\right)^{\gamma} \cdot \left(\frac{Lpp}{\nabla^{1/3}}\right)^{\delta}}$$ if $f_{jRoRo} > 1$ then $f_j = 1$

where:

- the Froude number, F_{n_L}, is defined as:
- $F_{n_L} = \frac{0.5144 \cdot V_{ref,F}}{\sqrt{L_{pp} \cdot g}}$
- $V_{ref,F}$ is the ship design speed corresponding to 75% of MCR_{ME} (without the deduction of overridable power limitation or power take-off such as from shaft generators)
- the exponents α, β, γ and δ are defined in Table 10.

Table 10

Ship type	Exponent:			
	α	β	γ	δ
Ro-ro cargo ship	2.00	0.50	0.75	1.00
Ro-ro passenger ship	2.50	0.75	0.75	1.00

- for **ro-ro cargo ships (vehicle carriers)** having a DWT/GT ratio of less than 0.35, the following cubic capacity correction factor applies:

$$f_{cVEHICLE} = \left(\frac{\left(\frac{DWT}{GT}\right)}{0.35} \right)^{-0.8}$$

4.10 $P_{[AE]eff}$, f_{eff}

$P_{[AE]eff}$ and $f_{eff(i)}$ are respectively the power of innovative energy efficiency technology and the relevant availability factor.

For waste energy recovery system $f_{eff(i)}$ may be assumed as one (1.0).

Reference is to be made to MEPC.1/Circ.896 concerning the calculation and verification of the effects of innovative energy efficiency technologies.

5 EEXI REVIEW AFTER ADOPTION OF PERFORMANCE ENHANCING MEASURES

In case of non-compliance with the requirement: **Attained EEXI ≤ Required EEXI,** consideration is to be given to carrying out modifications to the ships, such that:

- the numerator of the EEXI formula will decrease (normally action may be taken on P_{ME}, P_{AE} *or* P_{eff}) and/or
- the denominator of the EEXI formula will increase (normally action may be taken on *Capacity,* V_{ref}).

The actions to be evaluated are:

- the introduction of an Engine Power Limitation (EPL) or Shaft power limitation (ShaPoLi);

- for ships where the Electrical power table have been used to calculate P_{AE}, the introduction of energy efficient consumers and reconsideration of Electrical power table;
- the increase of V_{ref} by means of hydrodynamic improving devices (e.g. high efficiency propellers, propeller boss cap fins, Mewis duct, low friction paints, air lubrication); and
- the introduction of Innovative energy efficiency technology (e.g. waste heat recovery, wind assisted propulsion, photovoltaic cells).

The EEXI may be recalculated taking into account the effect of the modifications, but:

- an Engine Power Limitation or Shaft Power Limitation may require the advice or intervention of the Original Equipment Manufacturer (OEM), and is to be officially certified by means of a survey on board to also ascertain the actual power limitation arrangement;
- a revised power table is to be validated by either a survey on board (remote survey could be considered) or by reviewing the data recorded in data loggers, when fitted, and submitted for acceptance.

6 APPROVAL, SURVEY AND ONBOARD MANAGEMENT MANUAL

6.1 Approval of EEXI Technical File prior EPL/SHaPoLi on board

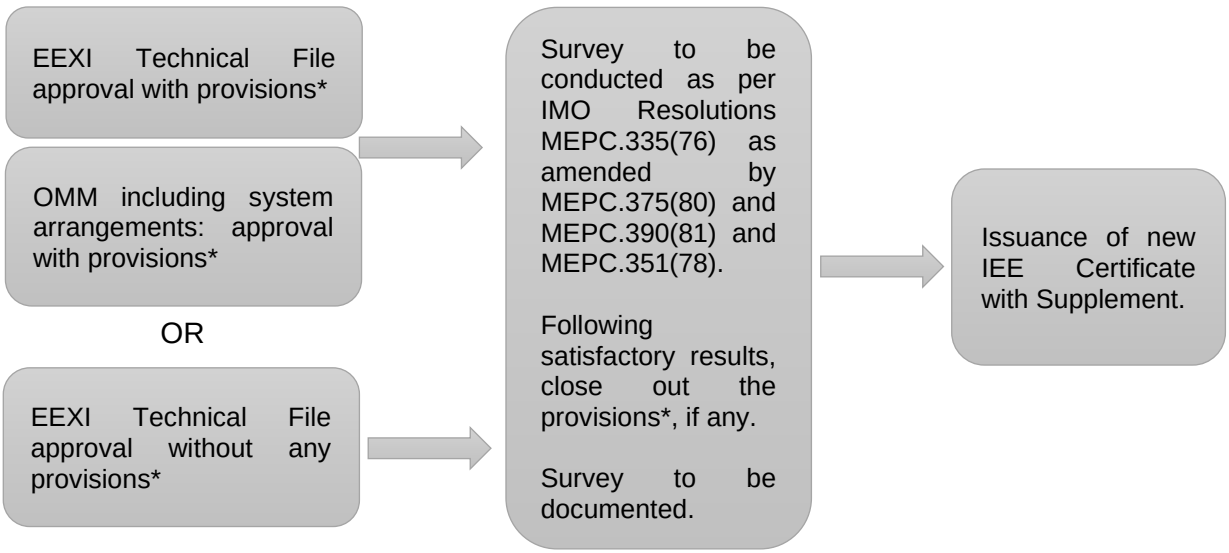
In case of EPL/SHaPoLi is intended to be implemented to satisfy the Required EEXI, the EEXI Technical File can be approved provided the following supporting documentation is included:

- *SFC* at new P_{ME} to be included. See [4.4] of this Guide.

For ships subject to the NO_x Technical Code: in case of change of engine critical settings or components, affecting NO_x Technical File, then NO_x Technical File to be amended and EIAPP reissued.

6.2 EEXI Technical File and OMM Approval Process

The following flowchart explains the route to the issuance of the new IEE Certificate with supplement:



* Provisions refer to the requirement that the power limitation will be installed as described in the EEXI Technical File.

EPL and OMM are subject to a survey onboard. The surveyor may issue the IEE Certificate only after having verified that the arrangements and procedures described in the OMM are in place.

Unless advised otherwise by the Flag Administration, the approval of EEXI Technical File and Onboard Management Manual (OMM) will be carried out based on the applicable IMO resolutions, complemented by the guidelines in this Guide.

6.3 On-Board Management Manual (OMM)

Paragraph 2.1.1.3 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) reads: "*a control unit for calculation and limitation of the power transmitted by the shaft to the propeller(s)* …omissis…". If this control is independent from the engine automation the following shall be satisfied:

- Override or exceeding of the limitation is indicated by giving an alarm on the bridge, clearly informing the ship's master or officer in charge of navigational watch OICNW:
  - In case of exceedance, the ship's master or OICNW to manually reduce the power within the limit;
  - In case of deliberate use of power reserve, data recording to commence automatically;
- Data recording device is to be installed and comply with paragraph 2.1.1.2 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81).

The OMM should clearly define this confirmation of the alarm as the deliberate action in agreement with requirement in paragraph 2.2.1 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81).

Paragraph 2.1.3 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) reads: *"where technically possible and feasible, the SHaPoLi/EPL system should be controlled from the ships' bridge and not require attendance in the machinery space by ship's personnel".* It is clarified that there is no mandatory requirement to retrofit a new control system from bridge provided in any critical operating condition (such as adverse weather, piracy, traffic separated zone, maneuvering)", other than normal seagoing, the engine control room will be manned as per ship's safety management system procedures. If applicable, this needs to be covered in the OMM.

Paragraph 2.2.4 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) reads: "*The SHaPoLi/EPL system (or each subsystem) should be tamper-proof*". It is clarified that the SHaPoLi/EPL system (or each sub system) is considered tamper-proof if it prevents the following actions:

- Overriding the limitation without authorization, from any operating or control position;
- If applicable, intentionally disabling the alerting-monitoring system;
- In case of SHaPoLi, intentionally disabling sensors, control unit, data recording and processing devices.

Paragraph 2.2.5.2 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) reads: *"for EPL, a fuel index sealing system or power limitation system which can indicate and record the use of unlimited mode"*. It is clarified that the indication and recording can be addressed via fuel index alarm set up and recording as per ship's existing systems, if suitable, provided these are stated in the OMM.

Paragraph 3.5 of Resolution MEPC.335(76) as amended by MEPC.375(80) and MEPC.390(81) reads: *"The reactivation or replacement of the SHaPoLi/EPL system should be confirmed (e.g. validation of mechanical sealing) with supporting evidence (e.g. engine power log, photo taken at the occasion of resetting the mechanical sealing) by the Administration or the RO at the earliest opportunity"*. In respect of the above requirement, confirmation may be based on supporting evidence submitted by the owner, if accepted by the Administration or the RO acting on its behalf.

6.4 NOx

In case overridable or non-overridable power limitation is proposed in the context of EEXI calculation, its possible effect on NOx is to be considered according to Table 11.

Table 11

	Amendment to NOx TF	Change engine name plate	EIAPP certificate to be reissued	OMM	MPP (see note 2)
Overridable					
EPL or SHaPoLi	No (see note 1)	No	No	Yes	No
Turbocharger cut-out by butterfly valve	Yes	No	No	Yes	No
Non-overridable (permanent during ship operation)					
Propeller retrofit with restricted shaft power to prevent damage	No	No	No	No	Yes (Level 2 assessment is required)
Turbocharger dismantling Turbocharger cut-out by removable blinding plate, e.g. bolted, or permanent blinding plate, welded	Yes	Yes	Yes (see note 3)	No	Yes
Permanent adjustment of fuel index	No	No	No	No	Yes (Level 2 assessment is required)
Permanent Engine derating	New NOx Technical File	Yes	Yes	No	Yes

Notes:
1. For EPL or SHaPoLi, in case of change of engine critical settings or components, affecting NOx Technical File (NTF), then NTF to be amended.
2. Minimum Propulsion Power Assessment as per Circular 850 is applicable only to bulk carriers, tankers, and combination carriers of 20,000 tonnes deadweight and above.
3. Only in case dismantling of turbocharger results in changed NOx emission value (g/kWh).

6.5 Barred Speed Range

In case overridable or non-overridable power limitation is proposed in the context of EEXI calculation, its possible interference with barred speed range is to be considered according to Table 12.

Table 12

Overridable	EPL or SHaPoLi	- The RPM corresponding to New MCR Power after the power limitation is to be outside the Barred Speed Range limit (RPM) with an operational margin of 25%, based on IACS UR M68. - The Barred Speed Range as indicated in the Torsional Vibration Calculation document needs to be made available during the review of EEXI Technical File.
Non-overridable	Permanent adjustment of fuel index	
Overridable	Turbocharger cut-out by butterfly valve	- New Torsional Vibration Calculations to be carried out and reviewed/approved. - The new Barred Speed Range as indicated in the newly Torsional Vibration Calculation document needs to be made available during the review of EEXI Technical File. - The RPM corresponding to new MCR Power after the power limitation is to be outside the new Barred Speed Range limit (RPM) with an operational margin of 25%, based on IACS UR M68.
Non-overridable	Turbocharger dismantling Turbocharger cut-out by removable blinding plate, i.e., bolted, or permanent blinding plate, e.g. welded	
Non-overridable	Propeller retrofit with restricted shaft power to prevent damage	- The RPM corresponding to new MCR Power after the power limitation is to be outside the new Barred Speed Range limit (RPM) with an operational margin of 25%, based on IACS UR M68.
Non-overridable	Permanent Engine derating	

APPENDIX 1 – SAMPLE OF THE EEXI TECHNICAL FILE

1 Data

1.1 General information

Shipowner	XXX Shipping Line
Shipbuilder	XXX Shipbuilding Company
Hull no.	12345
IMO no.	94112XX
Ship type	Bulk carrier

1.2 Principal particulars

Length overall	250.0 m
Length between perpendiculars	240.0 m
Breadth, moulded	40.0 m
Depth, moulded	20.0 m
Summer load line draught, moulded	14.0 m
Deadweight at summer load line draught	150,000 tons

1.3 Main engine

Manufacturer	XXX Industries
Type	6J70A
Maximum continuous rating (MCR_{ME})	15,000 kW x 80 rpm
Limited maximum continuous rating with the Engine Power Limitation installed ($MCR_{ME,lim}$)	9,940 kW x 70 rpm
SFC at 75% of MCRME or 83% of $MCR_{ME,lim}$	166.5 g/kWh
Number of sets	1
Fuel type	Diesel Oil

1.4 Auxiliary engine

Manufacturer	XXX Industries
Type	5J-200
Maximum continuous rating (MCR_{AE})	600 kW x 900 rpm
SFC at 50% MCR_{AE}	220.0 g/kWh
Number of sets	3
Fuel type	Diesel Oil

1.5 Ship speed

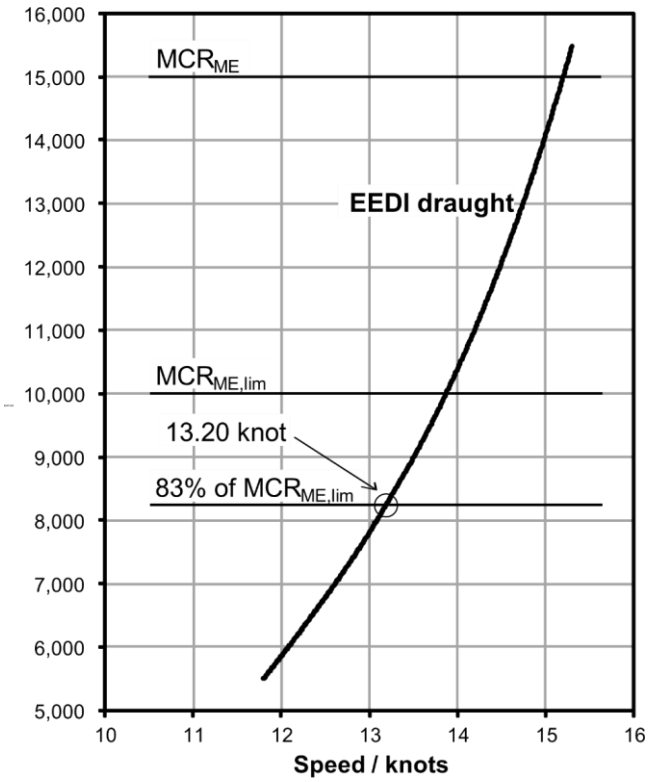
Ship speed (V_{ref}) (with the Engine Power Limitation installed)	13.20 knots

2 Power curve

(Example 1; case of the EEDI ship)
An approved speed-power curve contained in the EEDI Technical File is shown in Figure 1.

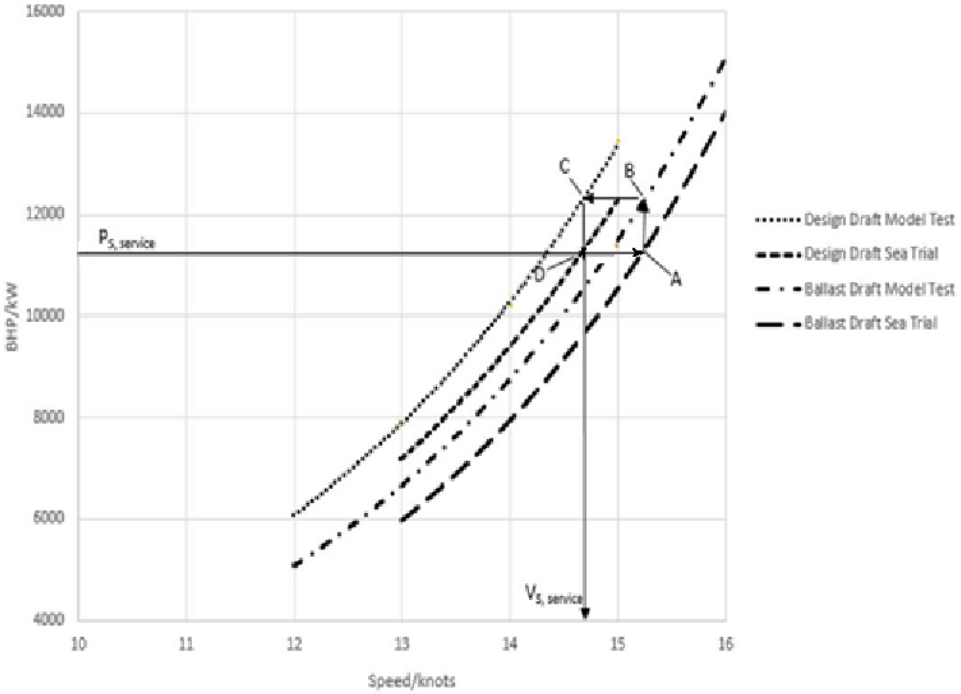
(Example 2; case of the pre-EEDI ship)
An estimated speed-power curve obtained from the tank test and/or numerical calculations, if available, is also shown in Figure 1.

Figure 1: Power curve



(Example 3; case of the pre-EEDI ship with sea trial result calibrated to a different load draught) An estimated speed-power curve under a ballast draught calibrated to the design load draught, obtained from the tank test and/or numerical calculations, if available, is shown in Figure 2.

Figure 2: Power curve



3 Overview of propulsion system and electric power supply system

3.1 Propulsion system

3.1.1 Main engine

Refer to paragraph [1.3] of this appendix.

3.1.2 Propeller

Type	Fixed pitch propeller
Diameter	7.0 m
Number of blades	4
Number of sets	1

3.2 Electric power supply system

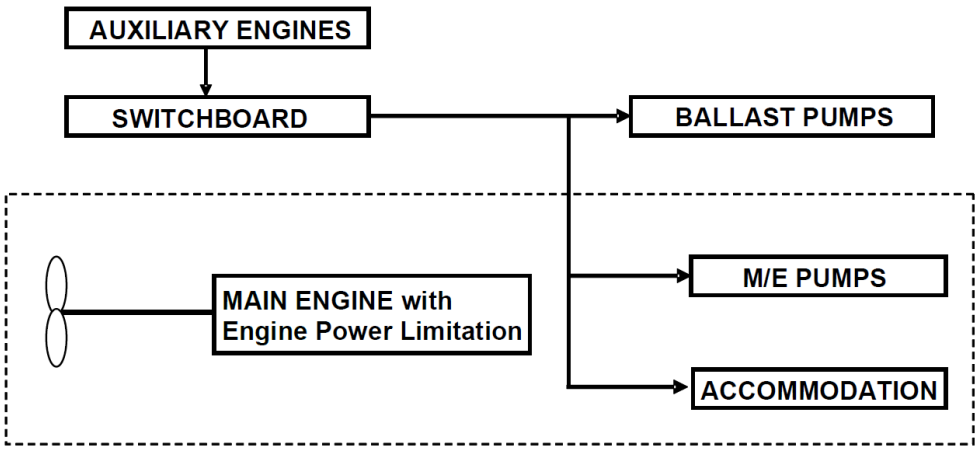
3.2.1 Auxiliary engines

Refer to paragraph [1.4] of this appendix.

3.2.2 Main generators

Manufacturer	XXX Electric
Rated output	560 kW (700 kVA) x 900 rpm
Voltage	AC 450 V
Number of sets	3

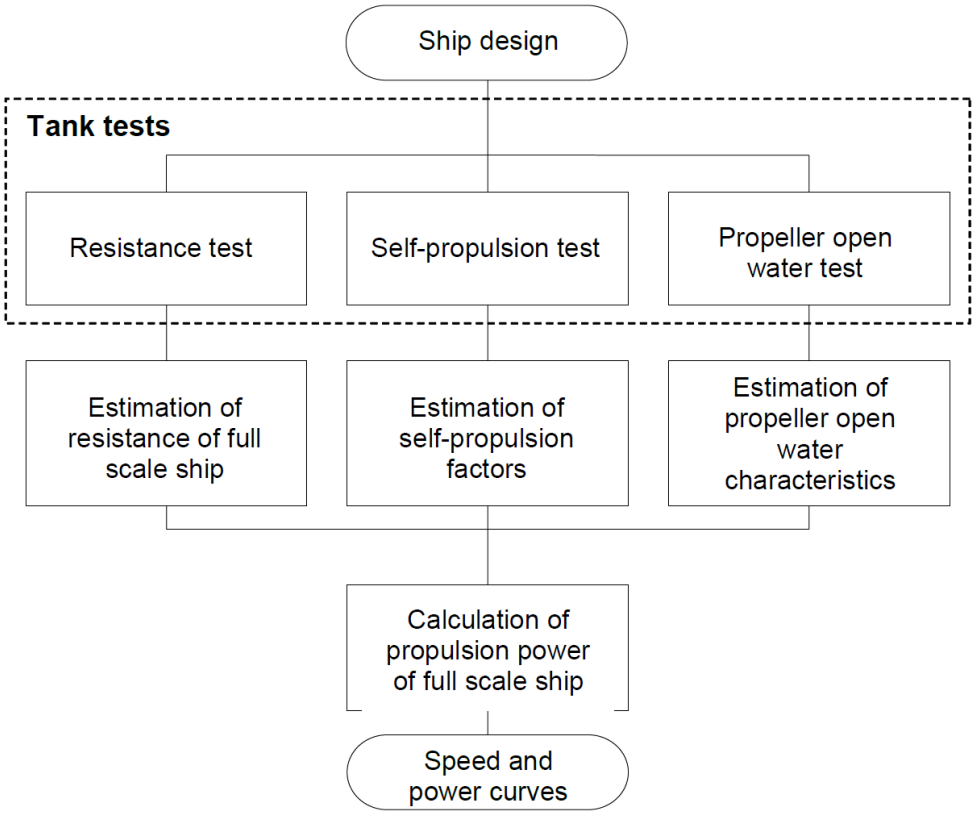
Figure 3: Schematic figure of propulsion and electric power supply system



4 Estimation process of speed-power curve

(Example; case of pre-EEDI ship)
Speed-power curve is estimated based on model test results and/or numerical calculations, if available. The flow of the estimation processes is shown in Figure 4.

Figure 4: Flow-chart of process for estimating speed-power curve from tank tests



5 Description of energy saving equipment

5.1 Energy saving equipment the effects of which are expressed as PAEeff(i) and/or Peff(i) in the EEXI calculation formula

N/A

5.2 Other energy saving equipment (Example)

5.2.1 Rudder fins

5.2.2 Rudder bulb

……

(Specifications, schematic figures and/or photos, etc. for each piece of equipment or device should be indicated. Alternatively, attachment of a commercial catalogue may be acceptable.)

6 Calculated value of Attained EEXI

6.1 Basic data

Type of ship	Capacity DWT	Speed V_{ref} (knots)
Bulk carrier	150,000	13.20

6.2 Main engine

MCR_{ME} (kW)	$MCR_{ME,lim}$ (kW)	P_{ME} (kW)	Type of fuel	C_{FME}	SFC_{ME} (g/kWh)
15,000	9,940	8,250	Diesel oil	3.206	166.5

6.3 Auxiliary engines

P_{AE} (kW)	Type of fuel	C_{FAE}	SFC_{AE} (g/kWh)
625	Diesel oil	3.206	220.0

6.4 Ice class

N/A

6.5 Innovative electrical energy efficient technology

N/A

6.6 Innovative mechanical energy efficient technology

N/A

6.7 Cubic capacity correction factor

N/A

6.8 Calculated value of Attained EEXI

$$EEXI = \frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + (P_{AE} \cdot C_{FAE} \cdot SFC_{AE})}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

$$+ \frac{\left\{\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) \cdot C_{FAE} \cdot SFC_{AE}\right\}}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

$$- \frac{\left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

$$= \frac{1 \times (8250 \times 3.206 \times 166.5) + (625 \times 3.206 \times 220.0) + 0 - 0}{1 \times 1 \times 1 \times 150000 \times 1 \times 13.20 \times 1}$$

$$= 2.45\ (g - CO_2/ton \cdot mile)$$

Attained EEXI: 2.45 g-CO_2/ton mile

7 Calculated value of Required EEXI

$$EEXI = (1\text{-}20/100) \times [(961.79 \times 150{,}000^{-0.477}] = 2.61\ g\text{-}CO_2/ton\ mile$$

Required EEXI: 2.61 g-CO_2/ton mile

***