ST KITTS & NEVIS INTERNATIONAL SHIP REGISTRY

MARITIME CIRCULAR – MC 117 22

NEW MANDATORY MEASURES TO CUT THE CARBON INTENSITY OF INTERNATIONAL SHIPPING

1. Purpose

1.1. The purpose of this Maritime Circular is to remind Maritime Registrars, Ship Owners, Ship Managers and Ship Operators about the new mandatory measures that have been adopted by the International Maritime Organization (IMO) to cut the carbon intensity of international shipping, and to inform that IMO has further developed and approved a number of relevant guidelines in order to support the implementation of adopted measures.

1.2. This Maritime Circular has to be read in conjunction with the Maritime Circular MC 106 21 issued on 7 September 2021.

2. Introduction

2.1. The amendments to MARPOL Annex VI will require ships to reduce their greenhouse gas emissions were adopted by the IMO *Resolution MEPC.328(76)* and are expected to enter into force on 1 November 2022, with the requirements for Energy Efficiency Existing Ship Index (EEXI) and annual operational carbon intensity indicator (CII) certification coming into effect from 1 January 2023.

2.2. The new measures will require all ships to calculate their EEXI following technical means to improve their energy efficiency, to establish their annual operational carbon intensity indicator (CII) and CII rating, and to enhance Ship Energy Efficiency Management Plan (SEEMP).

3. Entry into force

3.1. The amendments to MARPOL Annex VI are expected to enter into force on 1 November 2022, with the requirements for EEXI and CII certification coming into effect from 1 January 2023. This means that the first annual reporting will be completed in 2023, with the first rating given in 2024.

4. Guidelines

4.1. Since the adoption of the amendments to MARPOL Annex VI, IMO has further developed and approved a number of relevant guidelines to support the implementation. Following to the last meeting of the IMO Marine Environment Protection Committee (MEPC) in June 2022, the following Guidelines related to energy efficiency measures have been approved:

Ship Energy Efficiency Management Plan (SEEMP)

- 2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP) (Resolution MEPC.346(78);
- Guidelines for the verification and Company Audits by the Administration of Part III of the Ship Energy Efficiency Management Plan (SEEMP)(Resolution MEPC.347(78).

Fuel oil consumption of ships

- 2022 Guidelines for Administration verification of ship fuel oil consumption data and operational carbon intensity (Resolution MEPC.348(78);
- 2022 Guidelines for the development and management of the IMO Ship Fuel Oil Consumption Database (Resolution MEPC.349(78).

Energy Efficiency Existing Ship Index (EEXI)

- 2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI) (Resolution MEPC.350(78);
- 2022 Guidelines on survey and certification of the attained Energy Efficiency Existing Ship Index (EEXI) (Resolution MEPC.351(78)

Annual operational carbon intensity indicator (CII)

- 2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1) (Resolution MEPC.352(78);
- 2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII Reference Lines Guidelines, G2) (Resolution MEPC.353(78);
- 2022 Guidelines on the operational carbon intensity rating of ships (CII Rating Guidelines, G4) (Resolution MEPC.354(78);
- 2022 Interim Guidelines on correction factors and voyage adjustments for CII calculations (CII Guidelines, G5) (Resolution MEPC.355(78).

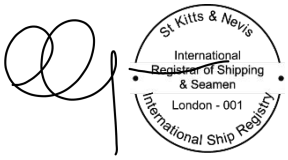
4.2. In addition *to the 2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI)* adopted by the *Resolution MEPC.350(78)*, the IMO has approved *the Guidance on methods, procedures, and verification of in-service performance measurements* for the purpose of the EEXI calculation. A copy of the Guidance can be found in the Annex to the IMO *Circular MEPC.1/Circ.901, attached.*

4.3. This Guidance was developed for the purpose of the EEXI calculation, in cases where the speed-power curve is not available or the sea trial report does not contain the EEDI or design load draught condition, then the ship speed Vref can be obtained from the in-service performance measurement method.

4.4. Also, IACS has developed EEXI Implementation Guidelines as *the IACS Recommendation No.172* to support the implementation of the IMO adopted measures by the *Resolutions MEPC.335(76)*, *MEPC.350(78)* and *MEPC.351(78)* relating to EEXI. A copy of the IACS Recommendation can be found in the attachment.

This Administration advises to familiarise yourself with the guidelines and guidance developed by IMO and IACS to support the implementation of the new energy efficiency requirements, and to revise the measures undertaken to improve the energy efficiency of your ships.

Yours truly,



Liam Ryan
International Registrar of Shipping and Seamen

ANNEX 8

RESOLUTION MEPC.346(78)
(adopted on 10 June 2022)

2022 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee, at its seventy-sixth session, adopted, by resolution MEPC.328(76), the 2021 revised MARPOL Annex VI, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the 2021 revised MARPOL Annex VI (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce the carbon intensity of international shipping,

NOTING FURTHER that regulation 26 of MARPOL Annex VI requires each ship to keep on board a Ship Energy Efficiency Management Plan (SEEMP), to be developed and reviewed, taking into account the guidelines adopted by the Organization,

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

NOTING that the Committee, at its seventieth session, adopted, by resolution MEPC.282(70), the *2016 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)*,

HAVING CONSIDERED, at its seventy-eighth session, the draft *2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)*,

1 ADOPTS the *2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 26 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulations 25.3 and 28.11 of MARPOL Annex VI a review of the technical and operational measures to reduce the carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2016 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)* adopted by resolution MEPC.282(70).

2022 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

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APPENDIX 4 – STANDARDIZED DATA REPORTING FORMAT FOR THE PARAMETERS TO CALCULATE THE TRIAL CARBON INTENSITY INDICATORS ON A VOLUNTARY BASIS

1 INTRODUCTION

1.1 The *Guidelines for the development of a Ship Energy Efficiency Management Plan* have been developed to assist with the preparation of the Ship Energy Efficiency Management Plan (SEEMP) required by regulation 26 of MARPOL Annex VI.

1.2 Taken together, the aims of the SEEMP should assist the international shipping sector to achieve the goal of Chapter 4 of MARPOL Annex VI set out in regulation 20, which is reducing the carbon intensity of international shipping. The aims of the SEEMP are threefold:

1.2.1 To encourage companies to incorporate actions to improve the energy efficiency and carbon intensity of their ships and ship management practices.

1.2.2 To specify the methodology the ship should use to collect the data required by regulation 27.1 of MARPOL Annex VI and the processes that should be used to report the data to the ship's Administration or any organization duly authorized by it.

1.2.3 To specify the methodology the ship should use to calculate the attained annual operational carbon intensity indicator (CII) as required by regulation 28.1 of MARPOL Annex VI and the processes that should be used to report the data to the ship's Administration or any organization duly authorized by it.

1.3 There are three parts to a SEEMP:

1.3.1 Guidance for Part I of the SEEMP required by regulation 26.1 of MARPOL Annex VI, is addressed in sections 3, 4, and 5 of these Guidelines. The purpose of this part is to provide an approach to monitor ship and fleet efficiency performance over time and describe ways to improve the ship's energy efficiency performance and carbon intensity. Part I of the SEEMP applies to any ship of 400 GT and above.

1.3.2 Guidance for part II of the SEEMP required by regulation 26.2 of MARPOL Annex VI, is addressed in sections 6, 7, and 8 of these Guidelines. The purpose of this part is to provide a description of the methodologies that should be used to collect the data required pursuant to regulation 27 of MARPOL Annex VI and the processes that the ship should use to report the data to the ship's Administration or any organization duly authorized by it. Part II of the SEEMP applies to any ship of 5,000 GT and above.

1.3.3 Guidance for part III of the SEEMP required by regulations 26.3 and 28.8 of MARPOL Annex VI is addressed in sections 9, 10, 11, 12, 13, 14 and 15 of these Guidelines. The purpose of this part is to provide:

.1 a description of the methodology that should be used to calculate the ship's attained annual operational CII required by regulation 28 of MARPOL Annex VI;

.2 the processes that should be used to report this value to the ship's Administration or any organization duly authorized by it;

.3 the required annual operational CII for the next three years;

.4 an implementation plan documenting how the required annual operational CII should be achieved during the next three years;

.5 a procedure for self-evaluation and improvement; and

.6 for ships rated as D for three consecutive years or rated as E, a plan of corrective actions to achieve the required annual operational CII.

1.3.4 Part III of the SEEMP applies to any ship of 5,000 GT and above which falls into one or more of the categories in regulations 2.2.5, 2.2.7, 2.2.9, 2.2.11, 2.2.14 to 2.2.16, 2.2.22, and 2.2.26 to 2.2.29 of MARPOL Annex VI.

1.3.5 Sample forms of the various sections of the SEEMP are presented in appendices 1, 2, and 2*bis* for illustrative purposes. A standardized data-reporting format for the data collection system and operational carbon intensity is presented in appendix 3. A standardized data reporting format for the trial carbon intensity indicators on voluntary basis is presented in appendix 4.

2 DEFINITIONS

2.1 For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

2.2 "Ship fuel oil consumption data" means the data required to be collected on an annual basis and reported as specified in appendix IX to MARPOL Annex VI.

2.3 "Safety management system" means a structured and documented system enabling company personnel to implement effectively the company safety and environmental protection policy, as defined in paragraph 1.1 of International Safety Management Code.

2.4 "Carbon Intensity Indicator" means a performance indicator by which it is possible to measure the carbon intensity of the ship, as defined in the guidelines developed by the Organization,[1] taking into account data listed for reporting in appendix IX to MARPOL Annex VI.

PART I OF THE SEEMP: SHIP MANAGEMENT PLAN TO IMPROVE ENERGY EFFICIENCY

3 GENERAL

3.1 Regulation 26.1 of MARPOL Annex VI requires each ship of 400 gross tonnage and above, subject to chapter 4 to keep on board a ship-specific Ship Energy Efficiency Management Plan (SEEMP).

3.2 The purpose of part I of the SEEMP is to establish a mechanism for a company and/or a ship to improve the energy efficiency and reduce the carbon intensity of a ship's operation. Preferably, this aspect of the ship-specific SEEMP is linked to a broader corporate energy management policy for the company that owns, operates or controls the ship, recognizing that no two shipping companies are the same, and that ships operate under a wide range of different conditions.

3.3 Many companies will already have an environmental management system (EMS) in place under ISO 14001 which contains procedures for selecting the best measures for particular ships and then setting objectives for the measurement of relevant parameters, along with relevant control and feedback features. Monitoring of operational environmental efficiency should therefore be treated as an integral element of broader company management systems.

[1] Refer to the *2021 Guidelines on operational carbon intensity indicators and the calculation methods (CII guidelines, G1)* (Resolution MEPC.336(76)) and the *2022 Guidelines on correction factors and voyage adjustments for CII calculations (G5)* (Resolution MEPC.XXX(78)).

3.4 In addition, many companies already develop, implement and maintain a safety management system. In such case, part I of SEEMP may form part of the ship's safety management system.

3.5 This section provides guidance for the development of part I of SEEMP that should be adjusted to the characteristics and needs of individual companies and ships. Part I of the SEEMP is intended to be a management tool to assist a company in managing the ongoing environmental performance of its ships and, as such, it is recommended that a company develop procedures for implementing the plan in a manner which limits any onboard administrative burden to the minimum necessary.

3.6 Part I of the SEEMP should be developed as a ship-specific plan by the company, and should reflect efforts to improve the energy efficiency and reduce carbon intensity of a ship through four steps: planning, implementation, monitoring, and self-evaluation and improvement. These components play a critical role in the continuous cycle to improve ship energy efficiency management and reduce its carbon intensity. With each iteration of the cycle, some elements of part I will necessarily change while others may remain as before.

3.7 At all times safety considerations should be paramount. The trade a ship is engaged in may determine the feasibility of the energy efficiency and carbon intensity reduction measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The nature of operations and influence of prevailing weather conditions, tides and currents combined with the necessity of maintaining safe operations may require adjustment of general procedures to maintain the efficiency of the operation, for example the ships which are dynamically positioned. The length of a voyage and the need to avoid high risk areas may also be important parameters as well as trade specific safety considerations.

4 FRAMEWORK AND STRUCTURE OF PART I OF THE SEEMP

4.1 Planning

4.1.1 Planning is the most crucial stage of part I of the SEEMP, in that it primarily determines both the current status of ship energy usage and carbon intensity and the expected improvement of ship energy efficiency and reduction of carbon intensity. Therefore, it is encouraged to devote sufficient time to planning so that the most appropriate, effective and implementable plan can be developed.

Ship-specific measures

4.1.2 Recognizing that there are a variety of options to improve energy efficiency and reduce carbon intensity (e.g. speed optimization, confirming berth availability and arrival time with port of destination, weather routeing, hull maintenance, retrofitting of energy efficiency devices, and use of alternative fuels), the best package of measures for a ship to improve energy efficiency and reduce carbon intensity depends to a great extent upon ship type, cargoes, routes and other factors that should be identified in the first place. These measures should be listed as a package of measures to be implemented, thus providing the overview of the actions to be taken for that ship.

4.1.3 During the planning process, therefore, it is important to determine and understand the ship's current status of energy usage. Part I of the SEEMP should identify energy-saving and carbon intensity reducing measures that already have been undertaken, and should determine how effective these measures are in terms of improving energy efficiency and

reducing carbon intensity. Part I also should identify what measures can be adopted to further improve the energy efficiency and reduce the carbon intensity of the ship. It should be noted, however, that not all measures can be applied to all ships, or even to the same ship under different operating conditions and that some of them are mutually exclusive. Ideally, initial measures could yield energy (and cost) saving results that then can be reinvested in more difficult or expensive efficiency upgrades identified by part I.

4.1.4 Guidance on best practices for fuel-efficient operation of ships, set out in chapter 5, can be used to facilitate this part of the planning phase. Also, in the planning process, particular consideration should be given to minimize any onboard administrative burden.

Company-specific measures

4.1.5 The improvement of energy efficiency and reduction of carbon intensity of ship operation does not necessarily depend on single ship management only. Rather, it may depend on many stakeholders including ship repair yards, shipowners, operators, charterers, cargo owners, fuel suppliers, ports and traffic management services. For example, "just in time" – as explained in paragraph 5.2.4 – requires good early communication among operators, ports and traffic management services. The better the coordination among such stakeholders, the more improvement can be expected. In most cases, such coordination or total management is better made by a company rather than by a ship. In this sense, it is recommended that a company should also establish an energy efficiency and carbon intensity management plan to improve the performance of its fleet (should it not have one in place already) and make necessary coordination among stakeholders.

Human resource development

4.1.6 For effective and steady implementation of the adopted measures, raising awareness of and providing necessary training for personnel both on shore and on board are an important element. Such human resource development is encouraged and should be considered as an important component of planning as well as a critical element of implementation.

Goal setting

4.1.7 The last part of planning is goal setting.

.1 For ships also subject to regulation 28 of MARPOL Annex VI, the goal setting should be consistent with the continuous CII improvements set out by that regulation, and should include the relevant information (see paragraph 9.7). These ships are also encouraged to consider setting ship-specific goals in addition to the applicable CII requirements that strive for additional energy efficiency improvements and carbon intensity reductions.

.2 For ships or companies not subject to regulation 28, there are no requirements to define a goal and to communicate it to the public, or to be a subject to external inspection, surveys, or audits with respect to the SEEMP. Nevertheless, a meaningful goal should be defined to serve as a signal on a company's commitment to improve the energy efficiency and carbon intensity of the ship. The goal can be set using different indicators, including the annual fuel consumption, Annual Efficiency Ratio (AER), cgDIST, Energy

Efficiency Operational Indicator (EEOI) or other carbon intensity indicators (CIIs).[2] In all cases, the goal should be measurable and easy to understand.

4.2 Implementation

Establishment of implementation system

4.2.1 After a ship and a company identify the energy efficiency and carbon intensity measures to be implemented, it is essential to establish a system for their implementation. This is done by developing the procedures for energy management, defining tasks associated with those procedures, and assigning those tasks to responsible personnel. The implementation system should include procedures to ensure execution of measures and specify defined levels of authority and lines of communication. Also, it should include procedures for internal audits and management review, where relevant. In sum, part I of the SEEMP should describe how each measure should be implemented and who the responsible person or persons are. The implementation period (start and end dates) of each selected measure should be indicated. The development of such an implementation system can be considered as a part of planning, and therefore may be completed at the planning stage.

Implementation and record-keeping

4.2.2 The planned measures should be carried out in accordance with the predetermined implementation system. Record-keeping for the implementation of each measure is beneficial for self-evaluation at a later stage and should be encouraged. If any identified measure cannot be implemented for any reason, the reason or reasons should be recorded for internal use. It is recommended that events and operational conditions outside the control of the ship's crew (for example, waiting for berths, extended port dwell times, operation in severe adverse weather) which may affect the ships rating be documented.

4.3 Monitoring

Monitoring tools

4.3.1 The energy efficiency of a ship should be monitored quantitatively. This should be done by an established method, preferably by an international standard. In many cases, the monitoring tool should target the goal indicator set out in paragraph 4.1.7 (e.g. AER, cgDIST, EEOI, or other CIIs as agreed by the Organization). If a quantitative goal is not defined for a ship, a quantitative performance indicator developed by the Organization (e.g. AER, EEOI, CII) or another internationally established tool should be selected. A ship subject to regulation 28 is likely to use the CII as its monitoring tool.

4.3.2 If used, these CIIs should be calculated in accordance with the guidelines developed by the Organization,[3] adjusted, as necessary, to a specific ship and trade.

4.3.3 Ships subject to regulation 28 may use other measurement tools in addition to the CII, if convenient and/or beneficial for a ship or a company. In the case where other monitoring

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[2] Refer to the *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII guidelines, G1)* (Resolution MEPC.352(78)) and the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)* (Resolution MEPC.355(78)).

[3] Refer to the *Guidelines for voluntary use of the ship energy efficiency operational indicator (EEOI)* (MEPC.1/Circ.684) and the *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII guidelines, G1)* (Resolution MEPC.352(78)) and the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)* (Resolution MEPC.355(78)).

tools are used, the reason for the use of the tool and the method of monitoring should be clarified at the planning stage.

4.3.4 It is highly advised to conduct monitoring at regular intervals for checking consistency of data and verification assistance. The ship's fuel oil consumption should be monitored using daily reporting, such as noon reports, or higher frequency data.

Establishment of monitoring system

4.3.5 It should be noted that whatever measurement tools are used, continuous and consistent and reliable data collection is the foundation of monitoring. To allow for meaningful and consistent monitoring, a monitoring system, including the procedures for collecting data and the assignment of responsible personnel, should be developed. The development of such a system can be considered as a part of planning, and therefore should be completed at the planning stage.

4.3.6 It should be noted that, in order to avoid unnecessary administrative burdens on ships' staff, monitoring should be carried out as much as possible by shore staff when the data can be automatically transferred, utilizing data obtained from existing required records such as the official and engineering logbooks and oil record books. Additional data could be obtained as appropriate.

Search and rescue

4.3.7 When a ship diverts from its scheduled passage to engage in search and rescue operations, and for which emissions are excluded pursuant to regulation 3, it is recommended that data obtained during such operations is not used in ship energy efficiency monitoring, and that such data should be recorded separately.

4.4 Self-evaluation and improvement

4.4.1 Self-evaluation and improvement is the final phase of the management cycle. This phase should produce meaningful feedback for the coming first stage, i.e. planning stage of the next improvement cycle.

4.4.2 The purpose of self-evaluation is to:

.1 evaluate the effectiveness of the planned measures and their implementation;

.2 deepen the understanding of the overall characteristics of the ship's operation such as what types of measures can or cannot function effectively, and how and/or why;

.3 comprehend the trend of the efficiency improvement of that ship; and

.4 develop the improved management plan for the next cycle through identification of further opportunities for improving energy efficiency and reducing carbon intensity.

4.4.3 For this process, procedures for self-evaluation of the ship energy efficiency management plan should be developed. Furthermore, self-evaluation should be implemented periodically by using data collected through monitoring. In addition, it is recommended that time be invested in identifying the cause and effect of the performance during the evaluated

period so lessons learned can be taken into account when revising and improving the next stage of the ship's energy efficiency management plan.

5 GUIDANCE ON BEST PRACTICES FOR FUEL-EFFICIENT OPERATION OF SHIPS

5.1 The search for energy efficiency and carbon intensity improvement across the entire transport chain takes responsibility beyond what can be delivered by the company alone. A list of all the possible stakeholders in the efficiency of a single voyage is long: obvious parties are designers, shipyards and engine manufacturers for the characteristics of the ship; and charterers, fuel suppliers, ports and vessel traffic management services, etc. for the specific voyage. All parties involved should consider the inclusion of efficiency measures in their operations both individually and collectively.

5.2 Fuel-efficient operations

Improved voyage planning

5.2.1 The optimum route and improved efficiency can be achieved through the careful planning and execution of voyages. Thorough voyage planning needs time, but a number of software tools are available to assist in voyage planning.

5.2.2 The *Guidelines for voyage planning*, adopted by resolution A.893(21), provide essential guidance for the ship's crew and voyage planners.

Weather routeing

5.2.3 Weather routeing has a high potential for efficiency savings on specific routes. It is commercially available for all types of ship and for many trade areas.

Just in time

5.2.4 Good early communication with the next port should be an aim in order to give maximum notice of berth availability and facilitate the use of optimum speed where port operational procedures support this approach.

5.2.5 Optimized port operation could involve a change in procedures involving different ship handling arrangements in ports. Port authorities should be encouraged to maximize efficiency and minimize delay.

Speed optimization

5.2.6 Speed optimization can produce significant savings. However, optimum speed means the speed at which the fuel used per tonne mile is at a minimum level for that voyage. It does not mean minimum speed; in fact, sailing at less than optimum speed will consume more fuel rather than less. Reference should be made to the engine manufacturer's power/consumption curve and the ship's propeller curve. Possible adverse consequences of slow speed operation may include increased vibration and problems with soot deposits in combustion chambers and exhaust systems. These possible consequences should be taken into account. For LNG carriers speed optimization means, quite often, a higher speed at the start of laden passages to control tanks pressure and at the end of ballast passages to use the operational LNG quantity needed for cargo tank cooling in propulsion instead of wasting in GCU or condenser steam dump. Charterers are generally aware of the improved efficiency of this speed pattern.

5.2.7 As part of the speed optimization process, due account may need to be taken of the need to coordinate arrival times with the availability of loading/discharge berths, etc. The number of ships engaged in a particular trade route may need to be taken into account when considering speed optimization.

5.2.8 A gradual increase in speed when leaving a port or estuary whilst keeping the engine load within certain limits may help to reduce fuel consumption.

5.2.9 It is recognized that under many charter parties the speed of the ships is determined by the charterer and not the operator. Efforts should be made when agreeing charter party terms to encourage the ship to operate at optimum speed in order to maximize energy efficiency.

Optimized shaft power

5.2.10 Operation at constant shaft RPM can be more efficient than continuously adjusting speed through engine power. The use of automated engine management systems to control speed rather than relying on human intervention may be beneficial.

5.2.11 When optimizing shaft power, due attention should be given to overall power system efficiency. For example, in some cases reducing load or shaft speed below the minimum necessary to operate energy recovery systems and shaft generators may increase overall emissions.

5.3 Optimized ship handling

Optimum trim

5.3.1 Most ships are designed to carry a designated amount of cargo at a certain speed for a certain fuel consumption. This implies the specification of set trim conditions. Loaded or unloaded, trim has a significant influence on the resistance of the ship through the water and optimizing trim can deliver significant fuel savings. For any given draft there is a trim condition that gives minimum resistance. In some ships, it is possible to assess optimum trim conditions for fuel efficiency continuously throughout the voyage. Design or safety factors may preclude full use of trim optimization.

Optimum ballast

5.3.2 Ballast should be adjusted taking into consideration the requirements to meet optimum trim and steering conditions and optimum ballast conditions achieved through good cargo planning.

5.3.3 When determining the optimum ballast conditions, the limits, conditions and ballast management arrangements set out in the ship's Ballast Water Management Plan are to be observed for that ship.

5.3.4 Ballast conditions have a significant impact on steering conditions and autopilot settings, and it needs to be noted that less ballast water does not necessarily mean improved energy efficiency.

Optimum propeller and propeller inflow considerations

5.3.5 Selection of the propeller is normally determined at the design and construction stage of a ship's life but new developments in propeller design have made it possible for retrofitting of later designs to deliver greater fuel economy. Whilst it is certainly for consideration, the

propeller is but one part of the propulsion train and a change of propeller in isolation may have no effect on efficiency and may even increase fuel consumption.

5.3.6 Improvements to the water inflow to the propeller using arrangements such as fins and/or nozzles could increase propulsive efficiency power and hence reduce fuel consumption.

Optimum use of rudder and heading control systems (autopilots)

5.3.7 There have been large improvements in automated heading and steering control systems technology. Whilst originally developed to make the bridge team more effective, modern autopilots can achieve much more. An integrated Navigation and Command System can achieve significant fuel savings by simply reducing the distance sailed "off track". The principle is simple: better course control through less frequent and smaller corrections will minimize losses due to rudder resistance. Retrofitting of a more efficient autopilot to existing ships could be considered.

5.3.8 During approaches to ports and pilot stations the autopilot cannot always be used efficiently as the rudder has to respond quickly to given commands. Furthermore, at certain stages of the voyage it may have to be deactivated or very carefully adjusted, i.e. during heavy weather and approaches to ports.

5.3.9 Consideration may be given to the retrofitting of improved rudder blade design (e.g. "twist-flow" rudder).

Hull maintenance

5.3.10 Docking intervals should be integrated with the company's ongoing assessment of ship performance. Hull resistance can be optimized by new technology-coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.

5.3.11 Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognized and facilitated by port States.

5.3.12 Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.

5.3.13 Generally, the smoother the hull, the better the fuel efficiency.

Propulsion system

5.3.14 Marine diesel engines have a very high thermal efficiency (~50%). This excellent performance is only exceeded by fuel cell technology with an average thermal efficiency of 60%. This is due to the systematic minimization of heat and mechanical loss. In particular, the new breed of electronic controlled engines can provide efficiency gains. However, specific training for relevant staff may need to be considered to maximize the benefits.

Propulsion system maintenance

5.3.15 Maintenance in accordance with manufacturers' instructions in the company's planned maintenance schedule will also maintain efficiency. The use of engine condition monitoring can be a useful tool to maintain high efficiency.

5.3.16 Additional means to improve engine efficiency might include use of fuel additives, adjustment of cylinder lubrication oil consumption, valve improvements, torque analysis, and automated engine monitoring systems.

5.4 Waste heat recovery

5.4.1 Waste heat recovery systems use thermal heat losses from the exhaust gas for either electricity generation, heating or additional propulsion with a shaft power take in.

5.4.2 It may not be possible to retrofit such systems into existing ships. However, they may be a beneficial option for new ships. Shipbuilders should be encouraged to incorporate new technology into their designs.

5.5 Improved fleet management

5.5.1 Better utilization of fleet capacity can often be achieved by improvements in fleet planning. For example, it may be possible to avoid or reduce long ballast voyages through improved fleet planning. There is opportunity here for charterers to promote efficiency. This can be closely related to the concept of "just in time" arrivals.

5.5.2 Efficiency, reliability and maintenance-oriented data sharing within a company can be used to promote best practice among ships within a company and should be actively encouraged.

5.6 Improved cargo handling

Cargo handling is in most cases under the control of the port or terminal operators and optimum solutions matched to ship and port or terminal requirements should be explored. However, in cases where ships use their own cargo handling equipment (e.g. cargo cranes, self-unloading booms, cargo pumps (tankers)), procedures should be in place to efficiently utilize the energy produced from any additional generators required to operate the equipment.

5.7 Energy management

5.7.1 A review of electrical services on board can reveal the potential for unexpected efficiency gains. However, care should be taken to avoid the creation of new safety hazards when turning off electrical services (e.g. lighting). Thermal insulation is an obvious means of saving energy. Also see comment below on shore power.

5.7.2 Optimization of reefer container stowage locations may be beneficial in reducing the effect of heat transfer from compressor units. This might be combined as appropriate with cargo tank heating, ventilation, etc. The use of water-cooled reefer plant with lower energy consumption might also be considered.

5.8 Fuel type

The use of emerging alternative fuels may be considered as a CO_2 reduction method, but availability will often determine the applicability.

5.9 Other measures

5.9.1 Development of computer software for the calculation of current fuel consumption, for the establishment of an emissions "footprint," to optimize operations, and the establishment of goals for improvement and tracking of progress may be considered.

5.9.2 Renewable energy sources, such as solar (or photovoltaic) cell technology, have improved enormously in recent years and should be considered for onboard application.

5.9.3 In some ports shore power may be available for some ships but this is generally aimed at improving air quality in the port area. If the shore-based power source is carbon efficient, there may be a net efficiency benefit. Ships may consider using onshore power if available.

5.9.4 Even wind-assisted propulsion may be worthy of consideration. Various systems are available for retrofit, including Flettner rotors, wing sails and aerofoil kites.

5.9.5 Efforts could be made to source fuel of improved quality in order to minimize the amount of fuel required to provide a given power output.

5.10 Compatibility of measures

5.10.1 These Guidelines indicate a wide variety of possibilities for energy efficiency improvements for the existing fleet. While there are many options available, they are not necessarily cumulative, are often area and trade dependent and likely to require the agreement and support of a number of different stakeholders if they are to be utilized most effectively.

Age and operational service life of a ship

5.10.2 All measures identified in this document as applied to part I of the SEEMP are potentially cost-effective in case of high oil prices. The financial feasibility of a specific energy efficiency enhancement can be evaluated by various means. One way would be to estimate the return on investment (ROI) time. However, while measures with lower ROI may have the lowest cost, this does not guarantee the best results in energy efficiency performance improvement. Clearly, this equation is heavily influenced by the remaining service life of a ship and the cost of fuel.

Trade and sailing area

5.10.3 The feasibility of many of the measures described in this guidance will be dependent on the trade and sailing area of the ship. Sometimes ships will change their trade areas as a result of a change in chartering requirements, but this cannot be taken as a general assumption. For example, certain types of wind-enhanced power sources might not be feasible for short sea shipping as these ships generally sail in areas with high traffic densities or in restricted waterways. Air draft limitations may also affect the feasibility of wind assistance technology and certain other emission reduction measures. Another aspect is that the world's oceans and seas each have characteristic conditions and so ships designed for specific routes and trades may not obtain the same energy efficiency benefits by adopting the same measures or combination of measures as other ships that operate in different areas. It is also likely that some measures will have a greater or lesser effect in different sailing areas.

5.10.4 The trade a ship is engaged in may also determine the feasibility of the efficiency measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The length of voyage may also be an important parameter as may trade specific safety considerations. The pathway to the most efficient combination of measures will be unique to each vessel within each shipping company.

5.10.5 Environmental conditions and the nature of cargo carried also varies between regions. For example, some routes may carry greater volumes of goods requiring careful temperature conditioning, or some transit regions may be subject to frequent severe adverse weather conditions. This may lead to an increase of emissions of ships serving those routes and regions.

PART II OF THE SEEMP: SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN

6 GENERAL

6.1 Regulation 26.2 of MARPOL Annex VI specifies that, "in the case of a ship of 5,000 gross tonnage and above, the SEEMP shall include a description of the methodology that will be used to collect the data required by regulation 27.1 of this Annex and the processes that will be used to report the data to the ship's Administration". Part II of the SEEMP, the Ship Fuel Oil Consumption Data Collection Plan (hereinafter referred to as "Data Collection Plan") contains such methodology and processes.

6.2 With respect to Part II of the SEEMP, these Guidelines provide guidance for developing a ship-specific method to collect, aggregate and report ship data with regard to annual fuel oil consumption, distance travelled, hours under way and other data required by regulation 27 of MARPOL Annex VI to be reported to the Administration.

6.3 Pursuant to regulation 5.4.5 of MARPOL Annex VI, the Administration should ensure that each covered ship's SEEMP complies with regulation 26.2 of MARPOL Annex VI prior to collecting any data.

7 GUIDANCE ON METHODOLOGY FOR COLLECTING DATA ON FUEL OIL CONSUMPTION, DISTANCE TRAVELLED AND HOURS UNDER WAY

Fuel oil[4] consumption

7.1 Fuel oil consumption should include all the fuel oil consumed on board including but not limited to the fuel oil consumed by the main engines, auxiliary engines, gas turbines, boilers and inert gas generator, for each type of fuel oil consumed, regardless of whether a ship is under way or not. Methods for collecting data on annual fuel oil consumption in metric tonnes include (in no particular order):

.1 method using bunker delivery notes (BDNs):

This method determines the annual total amount of fuel oil used based on BDNs, which are required for fuel oil for combustion purposes delivered to and used on board a ship in accordance with regulation 18 of MARPOL Annex VI; BDNs are required to be retained on board for three years after the fuel oil has been delivered. The Data Collection Plan should set out how the ship will operationalize the summation of BDN information and conduct tank readings. The main components of this approach are as follows:

[4] Regulation 2.1.14 of MARPOL Annex VI defines "fuel oil" as "fuel oil means any fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship, including gas, distillate and residual fuels."

.1 annual fuel oil consumption would be the total mass of fuel oil used on board the vessel as reflected in the BDNs. In this method, the BDN fuel oil quantities would be used to determine the annual total mass of fuel oil consumption, plus the amount of fuel oil left over from the last calendar year period and less the amount of fuel oil carried over to the next calendar year period;

.2 to determine the difference between the amount of remaining tank oil before and after the period, the tank reading should be carried out at the beginning and the end of the period;

.3 in the case of a voyage that extends across the data reporting period, the tank reading should occur by tank monitoring at the ports of departure and arrival of the voyage and by statistical methods such as rolling average using voyage days;

.4 fuel oil tank readings should be carried out by appropriate methods such as automated systems, soundings and dip tapes. The method for tank readings should be specified in the Data Collection Plan;

.5 the amount of any fuel oil offloaded should be subtracted from the fuel oil consumption of that reporting period. This amount should be based on the records of the ship's oil record book; and

.6 any supplemental data used for closing identified difference in bunker quantity should be supported with documentary evidence;

.2 method using flow meters:

This method determines the annual total amount of fuel oil consumption by measuring fuel oil flows on board by using flow meters. In case of the breakdown of flow meters, manual tank readings or other alternative methods will be conducted instead. The Data Collection Plan should set out information about the ship's flow meters and how the data will be collected and summarized, as well as how necessary tank readings should be conducted:

.1 annual fuel oil consumption may be the sum of daily fuel oil consumption data of all relevant fuel oil consuming processes on board measured by flow meters;

.2 the flow meters applied to monitoring should be located so as to measure all fuel oil consumption on board. The flow meters and their link to specific fuel oil consumers should be described in the Data Collection Plan;

.3 note that it should not be necessary to correct this fuel oil measurement method for sludge if the flow meter is installed after the daily tank as sludge will be removed from the fuel oil prior to the daily tank;

.4 the flow meters applied to monitoring fuel oil flow should be identified in the Data Collection Plan. Any consumer not monitored with a flow meter should be clearly identified, and an alternative fuel oil consumption measurement method should be included; and

.5 calibration of the flow meters should be specified. Calibration and maintenance records should be available on board;

.3 method using bunker fuel oil tank monitoring on board:

.1 to determine the annual fuel oil consumption, the amount of daily fuel oil consumption data measured by tank readings which are carried out by appropriate methods such as automated systems, soundings and dip tapes will be aggregated. The tank readings will normally occur daily when the ship is at sea and each time the ship is bunkering or de-bunkering; and

.2 the summary of monitoring data containing records of measured fuel oil consumption should be available on board;

.4 method using LNG cargo tank monitoring on board:

LNG ships use the Custody Transfer Monitoring System (CTMS) to monitor/record the cargo volumes inside the tanks. When calculating the consumption:

.1 the LNG liquid volume consumed is converted to mass using the methane density of 422 kg/m^3. This is because LNG is transported at methane boiling point, while other heavier hydrocarbons have a higher boiling point and remain at liquid state; and

.2 nitrogen mass content is subtracted for each laden voyage from LNG consumption as it does not contribute to CO_2 emissions;

.5 method using cargo tank monitoring on board for ships using cargo other than LNG as a fuel:

.1 to determine the annual fuel oil consumption, the amount of daily fuel oil consumption data measured by tank readings which are carried out by appropriate methods to the cargo used as a fuel. The method for tank readings should be specified in the SEEMP Data Collection Plan; and

.2 the tank readings will normally occur daily when the ship is at sea and each time the ship is loading or discharging cargo; and the summary of monitoring data containing records of measured fuel oil consumption should be available on board.

7.2 Any corrections, e.g. density, temperature, nitrogen content for LNG, if applied, should be documented.[5]

Conversion factor CF

7.3 If fuel oils are used that do not fall into one of the categories as described in the *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.308(73)), as amended, and have no CF-factor assigned (e.g. some "hybrid fuel oils"), the fuel oil supplier should provide a CF-factor for the respective product supported by documentary evidence.

Distance travelled

7.4 Appendix IX of MARPOL Annex VI specifies that distance travelled should be submitted to the Administration and:

.1 distance travelled over ground in nautical miles should be recorded in the logbook in accordance with SOLAS regulation V/28.1;[6]

.2 the distance travelled while the ship is under way under its own propulsion should be included in the aggregated data of distance travelled for the calendar year; and

.3 other methods to measure distance travelled accepted by the Administration may be applied. In any case, the method applied should be described in detail in the Data Collection Plan.

Hours under way

7.5 Appendix IX of MARPOL Annex VI specifies that hours under way should be submitted to the Administration. Hours under way should be an aggregated duration while the ship is under way under its own propulsion.

Data quality

7.6 The Data Collection Plan should include data quality control measures which should be incorporated into the existing safety management system. Additional measures to be considered could include:

.1 the procedure for identification of data gaps and correction thereof; and

.2 the procedure to address data gaps if monitoring data is missing, for example, flow meter malfunctions.

A standardized data reporting format

7.7 Regulation 27.3 of MARPOL Annex VI states that the data specified in appendix IX of the Annex are to be communicated electronically using a standardized form developed by the

[5] For example, ISO 8217 provides a method for liquid fuel.

[6] Distance travelled measured using satellite data is distance travelled over the ground.

Organization. The collected data should be reported to the Administration in the standardized format shown in appendix 3.

8 DIRECT CO_2 EMISSIONS MEASUREMENT

8.1 Direct CO_2 emission measurement is not required by regulation 27 of MARPOL Annex VI.

8.2 Direct CO_2 emissions measurement, if used, should be carried out as follows:

.1 this method is based on the determination of CO_2 emission flows in exhaust gas stacks by multiplying the CO_2 concentration of the exhaust gas with the exhaust gas flow. In case of the absence or/and breakdown of direct CO_2 emissions measurement equipment, manual tank readings will be conducted instead;

.2 the direct CO_2 emissions measurement equipment applied to monitoring is located so as to measure all CO_2 emissions from the ship. The locations of all equipment applied are described in the monitoring plan; and

.3 calibration of the CO_2 emissions measurement equipment should be specified. Calibration and maintenance records should be available on board.

PART III OF THE SEEMP: SHIP OPERATIONAL CARBON INTENSITY PLAN

9 GENERAL

9.1 Regulation 26.3.1 of MARPOL Annex VI specifies that, for certain categories of ships of 5,000 GT and above, on or before 1 January 2023, the SEEMP shall include:

.1 a description of the methodology that will be used to calculate the ship's attained annual operational CII required by regulation 28 of MARPOL Annex VI and the processes that will be used to report this value to the ship's Administration;

.2 the required annual operational CIIs, as specified in regulation 28 of MARPOL Annex VI, for the next three years;

.3 an implementation plan documenting how the required annual operational CIIs will be achieved during the next three years; and

.4 a procedure for self-evaluation and improvement.

9.2 Sections 9 to 15 of these Guidelines provide guidance for ships to which regulation 26.3 of MARPOL Annex VI applies for the following purposes:

.1 to assist them in developing part III of the ship's SEEMP, including guidance on developing a ship-specific method to collect necessary data;

.2 to describe the methodology that will be used to calculate the ship's attained annual operational CII value and report this to the ship's Administration;

.3 to determine the ship's required annual operational CII for the next three years;

.4 to develop and apply an implementation plan documenting how the required annual operational CIIs will be achieved during the next three years;

.5 to define a procedure for self-evaluation and improvement; and

.6 to develop corrective actions, as applicable.

9.3 The required annual operational CII is to be calculated in accordance with regulation 28 and taking into account the guidelines developed by the Organization.[7]

9.4 In addition, pursuant to regulation 28 of MARPOL Annex VI, part III of the SEEMP is further to include calculation methodologies and a plan of corrective actions for ships that are rated D for three consecutive years or rated as E.

9.5 The ship's attained annual operational carbon intensity is to be calculated taking into account the guidelines developed by the Organization.[8]

9.6 Ships of 5,000 gross tonnage and above that are subject to regulations 26.3 and 28 of MARPOL Annex VI are strongly encouraged to review part I of their SEEMP to revise it as needed to reflect the actions taken to achieve the ship's CII requirements.

9.7 The goal setting, as referred to in paragraph 4.1.7 in part I, should be consistent with the requirements of regulation 28 of MARPOL Annex VI and should include the ship's required annual operational CII for the next three years following the updating of the SEEMP.

9.8 In addition, while ships subject to regulation 28 of MARPOL Annex VI may relay on the CII requirements when defining goals under part I of the SEEMP, they are encouraged to consider setting additional ship-specific goals that go beyond the applicable CII requirements and strive for energy efficiency improvements and carbon intensity reductions beyond such requirements.

9.9 Ships subject to regulation 28 of MARPOL Annex VI may consider voluntarily using one or more of the trial CIIs (EEPI, cbDIST, clDIST or EEOI), where applicable, for the purpose of providing supporting data for decision-making to support the review clause set out in regulation 28.11 of MARPOL Annex VI. A standardized data reporting format for the parameters to calculate the trial carbon intensity indicators on a voluntary basis is presented in appendix 4. A description of the methodology that should be used to calculate the trial CII should be included in the SEEMP.

9.10 Part III of the ship's SEEMP should be updated in case of voluntary modifications or necessary corrective actions are involved (every three years).

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7 Refer to the *2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII reference lines guidelines, G2)* (Resolution MEPC.353(78) and the *2021 Guidelines on the operational carbon intensity reduction factors relative to reference lines (CII reduction factors guidelines, G3)* (Resolution MEPC.338(76).

8 Refer to the *2022 Guidelines on operational carbon intensity indicators and calculation methods (CII Guidelines, G1)* (Resolution MEPC.352(78)) and the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)* (Resolution MEPC.355(78)).

10 ATTAINED ANNUAL OPERATIONAL CII CALCULATION METHODOLOGY; DATA COLLECTION PLAN AND DATA QUALITY

10.1 Taking into account the guidelines developed by the Organization,[9] part III of the SEEMP provides detailed information on how the ship's attained annual operational CII should be calculated. Regulation 28 of MARPOL Annex VI states that the attained annual operational CII shall be calculated, using the data collected in accordance with regulation 27 (Fuel Oil Data Collection System).

10.2 In describing the calculation methodology, part III of the SEEMP should include a detailed description of the data required for the calculation of the attained annual operational CII. The data collection should follow the relevant methodology and requirements on the Fuel Oil Data Collection System pursuant to regulation 27 of MARPOL Annex VI (see part II of these Guidelines).

10.3 In case of transfer of the ship from one company to another according to regulation 27.5 or 27.6 of MARPOL Annex VI, all relevant data necessary for the calculation of the attained annual operational CII should be submitted by the former company to the receiving company within one month after the date of transfer. The data should have been verified by the Administration or any organization duly authorized by it according to regulation 6.7 of MARPOL Annex VI before they are transferred to the receiving company. The format of the transfer should be consistent with appendix 3 and such that the receiving company can use it in the calculations of the attained annual operational CII for the whole year in which the transfer takes place.

10.4 In case the former company does not transfer the required data, the Administration may make relevant data submitted to the IMO Fuel Oil Consumption Database available to the receiving company. In case of a transfer of both company and Administration concurrently, the incoming Administration may make a request to the Organization for access to the data according to regulation 27.11. If no such data is available, the attained annual operational CII can be calculated and verified using the available data covering a period of the preceding calendar year as long as practically possible.

10.5 In case of transfer of a ship from one Administration to another according to regulation 27.4 of MARPOL Annex VI the data needed for calculating the annual attained CII is already in the possession of the relevant company and no further exchange of data is needed.

11 REQUIRED ANNUAL OPERATIONAL CII FOR NEXT THREE YEARS

11.1 Part III of the SEEMP describes the required annual operational CII values for the ship for each of the next three years, calculated in accordance with regulation 28 of MARPOL Annex VI and taking into account the guidelines developed by the Organization,[10] as the basis for those calculations.

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[9] Refer to the *2022 Guidelines on operational carbon intensity indicators and calculation methods (CII Guidelines, G1)* (Resolution MEPC.352(78)) and the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)* (Resolution MEPC.355(78)).

[10] Refer to the *2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII reference lines guidelines, G2)* (Resolution MEPC.353(78)) and the *2021 Guidelines on the operational carbon intensity reduction factors relative to reference lines (CII reduction factors guidelines, G3)* (Resolution MEPC.338(76)).

12 THREE-YEAR IMPLEMENTATION PLAN

12.1 The three-year implementation plan describes the measures the ship plans to take to continue to achieve the required annual operational CII over the next three-year period. These may include, but are not limited to, measures as outlined in section 5 of these Guidelines.

12.2 The three-year implementation plan is ship-specific.

12.3 The three-year implementation plan should be SMART (Specific, Measurable, Achievable, Realistic, and Time-bound) to the extent envisaged and feasible. It should include:

.1 a list of measures that improve the energy efficiency and reduce the carbon intensity of the ship, with time and method of implementation necessary for achieving the required operational CII;

.2 a description of how, when the listed measures are implemented, the required operational CII will be achieved, taking into consideration the combined effect of the measures on operational carbon intensity;

.3 the company personnel responsible for the three-year implementation plan, and for monitoring and recording performance throughout the year for the reviewing of the effectiveness of the three-year implementation plan; and

.4 identification of possible impediments to the effectiveness of the measures for improving the energy efficiency and reducing the carbon intensity of the ship, including possible contingency measures put in place to overcome these impediments.

12.4 The three-year implementation plan should be monitored and adjusted when necessary, and the data to be monitored, identified.

13 PROCESS FOR SELF-EVALUATION AND IMPROVEMENT (IN ADDITION TO SECTION 4.4. OF THESE GUIDELINES)

13.1 The purpose of self-evaluation is to evaluate the effectiveness of the planned measures and their implementation, to deepen the understanding of the overall characteristics of the ship's operation, such as what types of measures can function effectively, and how or why, to comprehend the trend of the efficiency improvement of that ship, to understand trends in the ship's utilization in terms of cargo carried and areas of operation, and to develop an improved action plan for the next cycle. This evaluation should produce meaningful feedback based on experience in the previous period, to enhance performance in the next period.

13.2 Procedures for self-evaluation of the ship's energy usage and carbon intensity should be developed and included in this section of the SEEMP. Self-evaluation should be carried out periodically based on data collected through monitoring. It is recommended that the cause and effect of the ship's performance in the evaluated period be identified in order to identify measures for improving performance during the next period.

13.3 The process of self-evaluation and improvement could consist of the following elements:

.1 regular internal shipboard and company audits to verify implementation and the effectiveness of the system;

.2 improvement, i.e. implementing preventive or modifying measures (responsible personnel within the company should evaluate such audit reports and implement corrective actions including preventive or modifying measures); and

.3 periodical review of the SEEMP and associated documents, to update the SEEMP in a manner which minimizes any administrative and unnecessary burdens on company's personnel and ship's staff.

13.4 The content of the self-evaluation and improvement could include the following elements:

.1 criteria for evaluation, including elements to evaluate, such as quality of monitoring, record-keeping, effectiveness of implemented measures (including cause and effect) and achievement of the goal;

.2 the evaluation of the effectiveness of the different measures taken, in terms of energy efficiency and carbon intensity;

.3 which measures contribute the most and how much, which measures do not contribute and are therefore not efficient, which ship and/or company-specific elements adversely affect the CII and how these could be improved;

.4 timeline for starting the review process ahead of the end of the compliance period and for implementation of new measures in the subsequent year;

.5 measures identified to address deficiencies and discrepancies including correction of data gaps and system weaknesses, new measures to improve implementation (e.g. training) as well as new carbon intensity improvement measures as needed;

.6 where relevant, actions that will be taken to bring the ship into better CII ratings including estimated quantification of the additional expected reduction in carbon intensity;

.7 where applicable, if a plan of corrective actions is required, the plan should include items listed under 15.4.5 to bring the ship out of inferior performance; and

.8 where relevant, identification of critical factors that contributed to missing the CII target.

14 REVIEW AND UPDATE OF PART III OF THE SEEMP

14.1 Regulation 26.1 of MARPOL Annex VI provides: "Each ship shall keep on board a ship-specific Ship Energy Efficiency Management Plan (SEEMP). This may form part of the ship's safety management system. The SEEMP shall be developed and reviewed, taking into account guidelines adopted by the Organization". Regulation 26.3.2 of MARPOL Annex VI provides: "For ships rated as D for three consecutive years or rated as E, in accordance with regulation 28 of this Annex, the SEEMP shall be reviewed in accordance with regulation 28.8 of this Annex to include a plan of corrective actions to achieve the required annual operational CII".

14.2 The company should ensure that the SEEMP is reviewed and updated when necessary, as per paragraph 9.10.

14.3 The SEEMP should include a log for when it has been reviewed and updated and identify which parts have been changed.

15 PLAN OF CORRECTIVE ACTIONS

15.1 A plan of corrective actions is not required to be included in the SEEMP unless a ship has been rated D for three consecutive years or E for one year.

15.2 For a ship that is required to develop a plan of corrective actions in accordance with regulation 28.7 of MARPOL Annex VI, a revised SEEMP including the corrective actions for CII reduction shall be submitted to the Administration or any organization duly authorized by it for verification in accordance regulation 28.8 of MARPOL Annex VI. The revised SEEMP should be submitted together with, but in no case later than one month after reporting the attained annual operational CII in accordance with regulation 28.2.

15.3 Regulation 28.9 of MARPOL Annex VI further provides that "A ship rated as D for three consecutive years or rated as E shall duly undertake the planned corrective actions in accordance with the revised SEEMP."

15.4 Developing the plan of corrective actions

15.4.1 The purpose of the plan of corrective actions is to set out what actions a ship that was rated D for three consecutive years or E for one year should take to achieve at least a C rating for the calendar year following the adoption of the plan of corrective actions and ultimately the required annual operational CII.

15.4.2 The plan of corrective actions is ship-specific.

15.4.3 Many of the approaches described in section 5 of these guidelines or any other suitable measure may be applied to a ship to improve its fuel efficiency and thus its CII rating.

15.4.4 The plan for corrective action should describe the actions that the ship plans to take, the timeline in which those actions will be applied, and the expected impact their application will have on the ship's CII rating. It should be demonstrated how the corrective actions will contribute to achieving the required annual operational CII, so as to ascertain the effectiveness of the corrective actions. Experience gained from previously taken corrective actions and their degree of effectiveness should be taken into account when selecting the proper corrective actions.

15.4.5 The plan of corrective actions should be SMART (Specific, Measurable, Achievable, Realistic, and Time-bound). It should include:

.1 an analysis of the cause of the inferior CII rating;

.2 an analysis of the performance of implemented measures;

.3 a list of additional measures and revised measures to be added to the implementation plan with time and method of implementation necessary for achieving the required operational CII;

.4 designation of a company person to be responsible for the added and revised measures in the implementation plan, monitoring and recording performance throughout and reviewing of the effectiveness of the corrective actions; and

.5 identification of possible impediments to the effectiveness of the measures for improving the energy efficiency and reducing the carbon intensity of the ship, including possible additional contingency measures put in place to overcome and how these impediments will be overcome.

15.4.6 The implementation of the plan of corrective actions should be monitored and adjusted when necessary. Additional measures should be taken to strengthen corrective actions in case of insufficient intermediate results.

15.4.7 The company should ensure that it is in a position to perform the actions set out in the plan of corrective actions and confirm that it is able to do so when submitting its updated SEEMP.

APPENDIX 1

SAMPLE FORM OF SHIP MANAGEMENT PLAN TO IMPROVE ENERGY EFFICIENCY (PART I OF THE SEEMP)

Name of ship:		Gross tonnage:	
Ship type:		Capacity:	
IMO number:			

Date of development:		Developed by:	
Implementation period:	From: Until:	Implemented by:	
Planned date of next evaluation:			

Review and update log

Date/timeline	Updated parts	Developed by	Implemented by

1 MEASURES

Energy efficiency measures	**Implementation** (including the starting date)	**Responsible personnel**

2 MONITORING

Description of monitoring tools

3 GOAL

Measurable goals

4 EVALUATION

Procedures of evaluation

APPENDIX 2

SAMPLE FORM OF SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN (PART II OF THE SEEMP)

1 Review and update log

Date/timeline	Updated parts	Developed by	Implemented by

2 Ship particulars

Name of ship	
IMO number	
Company	
Flag	
Year of delivery	
Ship type	
Gross tonnage	
NT	
DWT	
Attained EEDI (if applicable)	
Attained EEXI (if applicable)	
Ice class	

3 Record of revision of Fuel Oil Consumption Data Collection Plan

Date of revision	Revised provision

4 Ship engines and other fuel oil consumers and fuel oil types used

	Engines or other fuel oil consumers	Power	Fuel oil types
1	Type/model of main engine	(kW)	
2	Type/model of auxiliary engine	(kW)	
3	Boiler	(…)	
4	Inert gas generator	(…)	

5 Emission factor

C_F is a non-dimensional conversion factor between fuel oil consumption and CO_2 emission in the *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.308(73)), as amended. The annual total amount of CO_2 is calculated by multiplying annual fuel oil consumption and C_F for the type of fuel.

Fuel oil type	C_F (t-CO_2 / t-Fuel)
Diesel/Gas oil (e.g. ISO 8217 grades DMX through DMB)	3.206
Light fuel oil (LFO) (e.g. ISO 8217 grades RMA through RMD)	3.151
Heavy fuel oil (HFO) (e.g. ISO 8217 grades RME through RMK)	3.114
Liquefied petroleum gas (LPG) (Propane)	3.000
Liquefied petroleum gas (LPG) (Butane)	3.030
Liquefied natural gas (LNG)	2.750
Methanol	1.375
Ethanol	1.913
Other (……)	

6 Method to measure fuel oil consumption

The applied method for measurement for this ship is given below. The description explains the procedure for measuring data and calculating annual values, measurement equipment involved, etc.

Method	Description

7 Method to measure distance travelled

Description

8 Method to measure hours under way

Description

9 Processes that will be used to report the data to the Administration

Description

10 Data quality

Description

APPENDIX 2*bis*

SAMPLE FORM OF SHIP OPERATIONAL CARBON INTENSITY PLAN (PART III OF THE SEEMP)

1 Review and update log

Date/timeline	Updated parts	Developed by	Implemented by
<1st time>			
<2nd time>			
Etc.			

2 Required CII over the next three years, attained CII and rating over three consecutive years

Name of the ship		IMO number	
Company		Year of delivery	
Flag		Ship type	
Gross tonnage		DWT	
Applicable CII		☐AER ; ☐cgDIST	

Year	Required annual operational CII	Attained annual operational CII (before any correction)	Attained annual operational CII	Operational carbon intensity rating (A, B, C, D or E):
<year -1>				
<year -2>				
<year -3>				

	Required annual operational CII
<year>:	
<year + 1>	
<year + 2>	

3 Calculation methodology of the ship's attained annual CII, including required data and how to obtain these data as far as not addressed in part II

Description

4 Three-year implementation plan

Description

Company personnel to be responsible for the three-year implementation plan, monitoring and recording performance

List of measures to be considered and implemented

Measure	Impact on CII	Time and method of implementation and responsible personnel	Impediments and contingency measures
		Milestone / Due / Responsible	Impediment / Contingencies
		Milestone / Due / Responsible	Impediment / Contingencies
		Milestone / Due / Responsible	Impediment / Contingencies
		Milestone / Due / Responsible	Impediments / Contingencies

Calculation showing the combined effect of the measures and that the required operational CII will be achieved

Year	Required annual operational CII	Targeted operational annual CII	Targeted rating
<year>:			
<year + 1>			
<year + 2>			

5 Self-evaluation and improvement

Description

6 Plan of corrective actions (if applicable)

Analysis of causes for inferior CII rating

Cause	Analysis of effect	Actions

Analysis of measures in the implementation plan

Measure	Analysis of effect	Actions

List of additional measures and revised measures to be added to the implementation plan

Measure	Impact on CII	Time and method of implementation and responsible personnel			Impediments and contingency measures	
		Milestone	Due	Responsible	Impediments	Contingencies

APPENDIX 3

STANDARDIZED DATA REPORTING FORMAT FOR THE DATA COLLECTION SYSTEM AND OPERATIONAL CARBON INTENSITY TO THE ADMINISTRATION

Name of the ship		IMO number	
Company		Year of delivery	
Flag		Ship type	
Gross tonnage		DWT	
Applicable CII		☐AER ; ☐cgDIST	
Operational carbon intensity rating		□A ; □B ; □C ; □D ; □E	
CII for trial purpose (none, one or more on voluntary basis)		□EEPI ; □cbDIST ; □clDIST ; □EEOI	

Attained annual operational CII before any correction (AER in g CO_2/dwt.nm or cgDIST in g CO_2/gt.nm)	
Attained annual operational CII (AER in g CO_2/dwt.nm or cgDIST in g CO_2/gt.nm)	
End date for annual CII (dd/mm/yy)*	
Start date for annual CII (dd/mm/yy)*	
Attained EEDI (if applicable)	
Attained EEXI (if applicable)	
EEPI (gCO_2/dwt.nm)	
cbDIST (gCO_2/berth.nm)	
clDIST (gCO_2/m.nm)	
EEOI (gCO_2/t.nm or others)	
……	
……	
IMO number	
End date for DCS (dd/mm/yy)	
Start date for DCS (dd/mm/yy)	

APPENDIX 4

STANDARDIZED DATA REPORTING FORMAT FOR THE PARAMETERS TO CALCULATE THE TRIAL CARBON INTENSITY INDICATORS ON VOLUNTARY BASIS*

Attained annual EEOI	
Metric of Cargo Mass Carried or Work Done in EEOI calculation (gCO_2/t.nm or others)*****	
Transport work*****	
Attained annual EEPI (gCO_2/dwt.nm)	
Laden distance travelled (n.m)	
Attained annual clDIST (gCO_2/m.nm) ****	
Length of lanes (metre) ****	
Attained annual cbDIST(gCO_2/berth.nm) ***	
Available lower berths***	
End date for trial CII (dd/mm/yy)**	
Start date for trial CII (dd/mm/yy)**	
IMO number**	
End date for DCS (dd/mm/yy)**	
Start date for DCS (dd/mm/yy)**	

* For reporting a trial CII, the data should be reported as applicable taking into account the information already provided in appendix 3.
** Consistent with appendix 3.
*** Only applicable to cruise passenger ships.
**** Only applicable to ro-ro ships.
***** As defined in section 3 of *Guidelines for voluntary use of the ship energy efficiency operational indicator (EEOI)* circulated by MEPC.1/Circ.684. The distance travelled shall be determined from berth of the port of departure to berth of the port of arrival and shall be expressed in nautical miles.

***

ANNEX 9

RESOLUTION MEPC.347(78)
(adopted on 10 June 2022)

GUIDELINES FOR THE VERIFICATION AND COMPANY AUDITS BY THE ADMINISTRATION OF PART III OF THE SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, at its seventy-sixth session, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI* which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 26 of MARPOL Annex VI requires each ship to keep on board a Ship Energy Efficiency Management Plan (SEEMP), to be developed and reviewed, taking into account the guidelines adopted by the Organization,

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

HAVING CONSIDERED, at its seventy-eighth session, draft *Guidelines for the verification and company audits by the Administration of part III of the Ship Energy Efficiency Management Plan (SEEMP)*,

1 ADOPTS the *Guidelines for the verification and company audits by the Administration of part III of the Ship Energy Efficiency Management Plan (SEEMP)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 26 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that, in accordance with regulations 25.3 and 28.11 of MARPOL Annex VI, a review of the technical and operational measures to reduce carbon intensity of international shipping shall be completed by 1 January 2026.

ANNEX

GUIDELINES FOR THE VERIFICATION AND COMPANY AUDITS BY THE ADMINISTRATION OF PART III OF THE SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

CONTENTS

1 INTRODUCTION

1.1 The *Guidelines for the verification and company audits by the Administration of part III* of *the Ship Energy Efficiency Management Plan (SEEMP)* have been developed to assist Administrations with carrying out the verifications and company audits required by regulation 26.3.3 of MARPOL Annex VI.

1.2 The aim of these Guidelines is to:

.1 provide guidance to Administrations to effectively and efficiently carry out verifications of, and company audits related to, the Ship Energy Efficiency Management Plan (SEEMP) to ensure compliance with regulation 26.3 and with regulation 28 of MARPOL Annex VI; and

.2 ensure that the SEEMP includes the relevant elements in accordance with regulation 26.3 of MARPOL Annex VI, as applicable, and that the SEEMP is reliable, while minimizing the costs and associated burdens to the ship and the Administration.

1.3 The verification of and the company audits related to the SEEMP may be carried out by the Administration or an organization recognized by it.[1]

1.4 It should be noted that the Organization has adopted separate *2022 Guidelines for Administration verification of ship fuel oil consumption data and operational carbon intensity* (resolution MEPC.348(78), adopted 10 June 2022).

2 DEFINITIONS

For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

3 RESPONSIBILITIES

3.1 The responsibilities of Administrations and ships are set out in MARPOL Annex VI. These Guidelines do not change those responsibilities or create any new obligations.

3.2 An Administration may authorize an organization to carry out verifications of, and company audits related to, the SEEMP, and issue the Confirmation of Compliance, submit the data to the Organization and perform other actions authorized by the Administration. In every case, the Administration assumes full responsibility for all tasks conducted by the Administration, or any organization duly authorized by it (hereinafter referred to as "the Administration").

3.3 Verification of, and company audits related to, the SEEMP do not relieve the company, management, those undertaking delegated SEEMP tasks, officers or seafarers of their obligations as to compliance with those requirements in regulation 28 of MARPOL Annex VI.

3.4 The company is responsible for:

.1 informing relevant personnel and those undertaking the delegated SEEMP tasks about the content of the SEEMP;

[1] Refer to the *Code for Recognized Organizations (RO Code)*, as adopted by the Organization by resolution MEPC.237(65), as may be amended by the Organization.

.2 appointing responsible members of staff to accompany the verifier; and

.3 providing access and evidential materials as requested by the verifier.

4 VERIFICATION OF THE SEEMP AND DOCUMENTATION

4.1 To facilitate the verification, the Administration should indicate what documentation, if any, the company should submit along with its SEEMP.

5 INITIAL, PERIODICAL, ADDITIONAL VERIFICATIONS AND COMPANY AUDITS

5.1 The verification and audit process for the SEEMP according to regulation 26.3.3 of MARPOL Annex VI should normally involve the following:

.1 initial verification;

.2 periodical verifications;

.3 additional verifications; and

.4 company audits.

5.2 The initial, periodical, additional verifications and company audits should be based on documentary evidence.

Initial verification (regulation 5.4.6 of MARPOL Annex VI)

5.3 The Administration should perform an initial verification to ensure that for each ship to which regulation 26.3 of MARPOL Annex VI applies, the SEEMP complies with regulation 26.3.1 of MARPOL Annex VI. In accordance with regulation 5.4.6 of MARPOL Annex VI, this process must be done prior to 1 January 2023 for existing ships or before a new ship is put in service.

5.4 On satisfactory assessment of the SEEMP part III, the Administration can issue the Confirmation of Compliance (sample format in the annex to this document).

Periodical verification (regulation 5.4.6 of MARPOL Annex VI)

5.5 If any of the elements in regulation 26.3.1 is updated, and in any case every three years, the Administration should perform a periodical verification to ensure the SEEMP complies with regulation 26.3.1 of MARPOL Annex VI in accordance with regulation 5.4.6 of MARPOL Annex VI.

5.6 On satisfactory assessment of SEEMP part III, the Administration should issue the Confirmation of Compliance (sample format in the annex to this document).

Additional verifications (regulation 6.8 of MARPOL Annex VI)

5.7 The Administration should, in the case of a ship rated as D for three consecutive years or a ship rated as E, perform an additional verification to ensure that a plan of corrective actions has been established in accordance with regulations 28.7 and 28.8.

5.8 On satisfactory verification of the plan of corrective actions, the Administration can issue the Statement of Compliance according to regulation 6.8.

Company audits

5.9 The Administration should, in accordance with regulation 26.3.3, perform periodical company audits to:

.1 verify that the SEEMP for which the Confirmation of Compliance has previously been issued complies with regulation 26.3.1 and, in the case of non-compliance, require remedial action;

.2 confirm that the ship is being operated in accordance with SEEMP part III, regardless of its rating;

.3 verify the progress made in the (corrective) actions to be taken in the execution of the three-year implementation plan and the plan of corrective actions;

.4 verify self-assessment and improvement of actions taken; and

.5 verify the assignment of responsibilities related to the implementation and monitoring of measures.

5.10 The periodical company audits may include annual audits of the company (company audits) and verifications on board the ship (shipboard audits).

5.11 These additional shipboard verifications and company audits, if undertaken, should be six months after the issuance of the Statement of Compliance at the latest.

6 ELEMENTS OF VERIFICATION

6.1 Verification could consist of, but not be limited to, the following elements:

.1 verification of the method of calculations of the CII and that there is a proper description of the method to report ship data to the Administration;

.2 assessment of the effectiveness (of the combination) of measures, so that when implemented the ship will with reasonable assurance achieve the required annual operational CII, including the goal as set in accordance with paragraph 4.1.7 and 9.7 of the SEEMP Guidelines; and

.3 robustness of the three-year implementation plan and, where applicable, the plan of corrective actions, including whether realistic timelines for implementation of actions have been included.

7 COMBINATION WITH ISM AUDITS

7.1 Verification of implementation aspects of the SEEMP on board (monitoring, self-evaluation and improvements, etc.) could be combined with the ISM audits.

7.2 The verifications may be carried out in accordance with guidelines on implementation of the ISM Code referred to in Chapter 15 of the ISM Code.

ANNEX

SAMPLE FORMAT FOR CONFIRMATION OF COMPLIANCE

CONFIRMATION OF COMPLIANCE – SEEMP PART III

Issued under the provisions of the Protocol of 1997, as amended, to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related thereto (hereinafter referred to as "the Convention") under the authority of the Government of:

. . . .

(full designation of the Country)

by . . . .

(full designation of the competent person or organization authorized under the provisions of the Convention)

Particulars of ship*

Name of ship . . . .

Distinctive number or letters. . . . .

IMO number†. . . . .

Port of registry . . . .

Gross tonnage. . . . .

SEEMP part III date of revision, as applicable . . . .

THIS IS TO CONFIRM:

Taking into account the *2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)* adopted by resolution MEPC.346(78), the ship's SEEMP has been developed and complies with regulation 26.3.1 of Annex VI of the Convention.

Issued at: . . . .

(place of issue of the Confirmation)

Date (dd/mm/yyyy) . . . .

(date of issue) *(signature of duly authorized official issuing the Confirmation)*

(seal or stamp of the authority, as appropriate)

* Alternatively, the particulars of the ship may be placed horizontally in boxes.

† In accordance with the IMO Ship Identification Number Scheme, adopted by the Organization by resolution A.1117(30).

***

ANNEX 10

RESOLUTION MEPC.348(78)
(adopted on 10 June 2022)

2022 GUIDELINES FOR ADMINISTRATION VERIFICATION OF SHIP FUEL OIL CONSUMPTION DATA AND OPERATIONAL CARBON INTENSITY

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING ALSO that regulation 27.7 of MARPOL Annex VI requires that ship fuel oil consumption data be verified according to procedures established by the Administration, taking into account guidelines developed by the Organization,

NOTING FURTHER that regulation 28.6 of MARPOL Annex VI specifies that the attained annual operational CII shall be documented and verified against the required annual operational CII to determine operational carbon intensity rating, taking into account the guidelines developed by the Organization,

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

NOTING that the Committee, at its seventy-first session, adopted, by resolution MEPC.292(71), the *2017 Guidelines for Administration verification of ship fuel oil consumption data,*

HAVING CONSIDERED, at its seventy-eighth session, draft *2022 Guidelines for Administration verification of ship fuel oil consumption data and operational carbon intensity*,

1 ADOPTS the *2022 Guidelines for Administration verification of ship fuel oil consumption data and operational carbon intensity*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 27 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulations 25.3 and 28.11 of MARPOL Annex VI a review of the technical and operational measures to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2017 Guidelines for Administration verification of ship fuel oil consumption data* adopted by resolution MEPC.292(71).

ANNEX

2022 GUIDELINES FOR ADMINISTRATION VERIFICATION OF SHIP FUEL OIL CONSUMPTION DATA AND OPERATIONAL CARBON INTENSITY

1 INTRODUCTION

1.1 Regulation 27 of MARPOL Annex VI establishes the IMO Ship Fuel Oil Consumption Database, to be administered by the Organization, to which each Administrations will submit relevant data for their registered ships of 5,000 gross tonnage (GT) and above. Regulation 27.7 specifies that "the data shall be verified according to procedures established by the Administration, taking into account guidelines developed by the Organization".

1.2 Regulation 28 of MARPOL Annex VI establishes the operational carbon intensity rating mechanism. Regulation 28.6 specifies that the attained annual operational CII shall be documented and verified against the required annual operational CII to determine operational carbon intensity rating A, B, C, D or E, either by the Administration or by any organization duly authorized by it, taking into account the guidelines developed by the Organization.

1.3 This document contains the Guidelines referred to in regulations 27.7 and 28.6 and is intended to assist Administrations in developing their own verification programme.

1.4 A verification procedure should ensure the reliability of the collected data and the correctness of the attained annual operational CII, while minimizing the costs and associated burdens to the ship and the Administration.

2 DEFINITIONS

For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

3 RESPONSIBILITIES

3.1 The responsibilities of Administrations and ships are set out in MARPOL Annex VI. These Guidelines do not change those or create any new obligations.

3.2 Under the data collection system for fuel oil consumption and the operational carbon intensity rating of ships, as specified in MARPOL Annex VI, an Administration may authorize an organization[1] to receive the data from a ship, verify the data for compliance with the requirements, verify the attained annual operational CII against the required annual operational CII, determine the operational carbon intensity rating, issue the Statement of Compliance, and submit the data to the Organization. In every case, the Administration assumes full responsibility for all tasks conducted by the Administration or any organization duly authorized by it (hereinafter referred to as "the Administration").

4 VERIFICATION OF THE REPORTED DATA

4.1 To facilitate data verification, the Administration should indicate what additional documentation a ship should submit along with its annual data report. Specification of this

[1] Refer to the *Guidelines for the authorization of organizations acting on behalf of the Administration*, adopted by the Organization by resolution A.739(18), as amended by resolution MSC.208(81), and the *Specifications on the survey and certification functions of recognized organizations acting on behalf of the Administration*, adopted by the Organization by resolution A.789(19), as may be amended by the Organization.

documentation can be done on a ship basis, as part of the assessment of the Data Collection Plan,[2] or it may be done as a general policy statement or through such other policy instruments as the Administration deems appropriate. Additional documentation to facilitate data verification may include the following, as well as other documentation that the Administration deems relevant:

.1 a copy of the verified ship's Data Collection Plan (SEEMP Part II);

.2 summaries of bunker delivery notes (BDNs), in sufficient detail to show that all fuel oil consumed by the ship is accounted for (see sample form of BDN summary set out in appendix 1);

.3 summaries of disaggregated data of fuel oil consumption, distance travelled and hours under way, in a format specified by the Administration (see sample form of data summary set out in appendix 2);

.4 information to demonstrate that the ship followed the Data Collection Plan set out in its SEEMP, including information on data gaps and how they were filled as well as how the event that caused the data gap was resolved;

.5 copies of documents containing information on the amount of fuel oil consumption, distance travelled and hours under way for the ship's voyages during the reporting period (e.g. the ship's official logbook, oil record book, BDNs, arrival/noon/departure reports, and from auto-log data files); and

.6 supported by documentary evidence, copies of the fuel oil mass to CO_2 mass conversion factor provided by fuel supplier in case the type of fuel is not covered by the guidelines developed by the Organization.[3]

4.2 In addition to the documentation described in paragraph 4.1, the Administration may request a ship to submit such documentation needed to perform a comprehensive review of a ship's annual fuel oil consumption, distance travelled, and hours under way. The Administration may request that this documentation be submitted by all ships or a subset of the ships under its jurisdiction. This documentation may be used by the Administration to verify whether the ship followed the methodology specified in its Data Collection Plan, with a view to confirming:

.1 consistency of reported data and calculated values, including with previous reporting periods (if applicable), through recalculating the annual reported values using the underlying data, etc.;

.2 completeness of data (e.g. perform substantive testing based on reconciliation, recalculations, and document cross-check, for example with official logbook and/or arrival/noon/departure reports, auto-log report files; recalculate total quantities of fuel oil used, distance travelled and hours under way); and

.3 reliability and accuracy of the data (e.g. test that the data quality procedures as described in the Data Collection Plan have been properly implemented, carry out site visits (typically to the company's offices rather than to the ship) to test the systems, processes and the control activities) through

[2] Refer to the *2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)*, adopted by resolution MEPC.346(78).

[3] Refer to the *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.308(73)), as may be amended.

corroborating fuel oil consumption data with distance travelled and hours under way, comparing reported fuel oil consumption with that which is expected for the ship size, operational profile, and technical characteristics, and/or comparing reported fuel oil consumption total fuel bunkered, etc.

4.3 For a ship which has undergone a transfer addressed in regulations 27.4, 27.5 or 27.6 of MARPOL Annex VI, the losing Administration needs to verify the data before the transfer.

5 VERIFICATION OF THE ATTAINED ANNUAL OPERATIONAL CII AND DETERMINATION OF THE CII RATING

5.1 To facilitate the verification of the attained annual operational CII, the Administration should indicate what additional documentation a ship should submit along with its annual data report. Additional documentation to facilitate the verification may include the following, as well as other documentation that the Administration deems relevant:

.1 a copy of the verified ship's Operational Carbon Intensity Plan (SEEMP part III);

.2 documents (IEE certificate, Stability Booklet or International Tonnage Certificate) evidencing the capacity parameter of the ship in the metric relevant for the calculation of its operational carbon intensity (deadweight or gross tonnage);

.3 aggregated data of fuel oil consumption and distance travelled covering the entire calendar year to calculate the attained annual operational CII (AER or cgDIST) (see sample form of data summary set out in appendix 2);

. 4 the aggregated values of the parameters and associated calculation methods to determine the annual metric value of the trial CIIs on voluntary basis, if any (see sample form of data summary set out in appendix 2 – Add.1);

.5 supported by documentary evidence, the correction factors and voyage adjustments[4] applied in the attained annual operational CII calculation, if any, during the reporting period (see sample form of data summary set out in appendix 2); and

.6 statements of compliance for previous two calendar years where applicable.

5.2 The attained annual operational CII should be verified using the data over a 12-month period from 1 January to 31 December for the preceding calendar year, by the Administration. In cases where the calculation of the attained annual operational CII is not possible due to the unavailability of some data, such as where a new ship is delivered after 1 January in the preceding year, the attained annual operational CII should be verified using the available data covering the corresponding period of the preceding calendar year.

5.3 In case of a ship with multiple load line certificates or with a load line certificate containing multiple load lines, the highest deadweight value should be used to calculate and verify the required and attained annual operational CII.

[4] Refer to the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations* (G5), adopted by resolution MEPC.355(78).

5.4 For a ship which permanently changes its deadweight (DWT) and/or its gross tonnage (GT) during the year, which the SEEMP or a corrective action plan identifies as being undertaken to improve the ship's operational carbon intensity performance:

.1 the required annual operational CII should always be calculated and verified using the original DWT or GT value before conversion; however, the attained CII which is used to assess compliance should be calculated and verified using the new DWT or GT value after conversion; and

.2 for the year when the conversion is made, the attained annual operational CII should be calculated and verified for the entire calendar year on the average DWT or GT value weighted on distance travelled before and after conversion.

5.5 Except for those specified in 5.4, for a ship which is regarded by the Administration as a newly constructed ship as per regulation 5.4.3 of MARPOL Annex VI due to major conversion, including extensive changes of carrying capacity and/or ship type during the year, the required and attained annual operational CII should be calculated and verified as per a newly constructed ship for the period after conversion. For the year when the major conversion is made, the data for partial year before conversion should still be reported for verification but will not be included in the calculation and verification of the attained annual operational CII.

5.6 For a ship which has undergone a transfer addressed in regulations 27.4, 27.5 or 27.6 of MARPOL Annex VI, the losing Administration neither needs to verify the attained annual operational CII nor to determine the annual CII rating of the ship for partial year. The attained annual operational CII should be verified by the receiving Administration using the data over an entire calendar year. In such cases, the aggregated data necessary to calculate the attained annual operational CII before transfer, which should have already been verified by the losing Administration, can be directly used by the receiving Administration without further verification (see sample form set out in appendix 3 and appendix 3 – Add.1).

5.7 The administration should determine the operational carbon intensity rating for the ship, taking into account the guidelines developed by the Organization.[5] The attained and required annual operational CII, as well as the rating boundaries, should be all given with three decimal places. If the attained annual operational CII happens to land on a rating boundary, the ship should be rated as the better of the two ratings.

5.8 The trial CIIs (e.g. EEPI, cbDIST, clDIST or EEOI),[6] if voluntarily calculated and reported, should be verified by the Administration following the same procedure as for the attained annual operational CII (AER or cgDIST). The Administration does not need to assign a rating to a ship based on trial CIIs.

6 ISSUE OF A STATEMENT OF COMPLIANCE

6.1 In accordance with regulation 6.6 of MARPOL Annex VI, upon receipt of reported data pursuant to regulation 27 of MARPOL Annex VI and attained annual operational CII pursuant to regulation 28 of MARPOL Annex VI and satisfactory completion of the verification, the Statement of Compliance should be issued by the Administration.

---

5 Refer to the *2022 Guidelines on the operational carbon intensity rating of ships (CII Rating Guidelines, G4)* adopted by resolution MEPC.354(78).

6 Refer to the *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)* adopted by resolution MEPC.352(78).

6.2 Notwithstanding paragraph 6.1, the Administration should consider whether a corrective action plan is required according to regulation 6.8 of MARPOL Annex VI. In the case of a corrective actions plan being required but not submitted together with the attained annual operational CII, the administration should inform the company in a timely manner that a revised SEEMP including a plan of corrective actions, must be submitted for verification no later than one month after reporting the attained annual operational CII. The Statement of Compliance should not be issued in such a case unless a corrective action plan is duly developed and reflected in the SEEMP and verified by the Administration, taking into account the guidelines developed by the Organization.[7]

6.3 Should any material discrepancy be identified by the Administration in the reported data and/or the calculation of required/attained annual operational CII, it should be communicated to the company on a timely basis for clarification or correction. A discrepancy is considered material if the discrepancy or aggregation of discrepancies could influence the reported total by more than ±5%. The Statement of Compliance should not be issued in such a case unless the material discrepancy is clarified or corrected.

[7] Refer to the *Guidelines for the verification and company audits by the Administration of part III of the Ship Energy Efficiency Management Plan (SEEMP)* adopted by resolution MEPC.347(78).

APPENDIX 1

SAMPLE OF THE BDN SUMMARIES

Date of Operations (dd/mm/yyyy)	Fuel Oil Type/Mass(MT)									Descriptions
	DO/GO	LFO	HFO	LPG(P)	LPG(B)	LNG	Methanol	Ethanol	Others(CF)	
① BDN										
09/01/2023										
02/05/2023			150							
08/07/2023										
09/10/2023										
10/12/2023			300							
①Annual Supply Amount	0	0	450	0	0	0	0	0	0	
② Correction for the tank oil remainings										
01/01/2023			400							
31/12/2023			200							
②Correction for the tank oil remaining	0	0	200	0	0	0	0	0	0	The difference in the amount of the remaining tank oil at the beginning/end of the data collection period.
③ Other corrections										
30/03/2023										
15/09/2023										
31/12/2023										
③Annual other corrections	0	0	0	0	0	0	0	0	0	
Annual Fuel Consumption										
Annual Fuel Consumption (①+②+③)	0	0	650	0	0	0	0	0	0	

Explanatory remarks;
If bunker supply/correction data have been recorded in a Company's electronic reporting system,the data is acceptable to be submitted in the existing format instead of submitting the data by this format.

APPENDIX 2

SAMPLE OF THE COLLECTED DATA SUMMARIES

Date and time from (dd/mm/ yyyy; hh:mm UTC)	* Date and time to (dd/mm/ yyyy; hh:mm UTC)	Distance travelled (n.m)	Hours under way (hh:mm)	**exceptional conditions specified in regulation 3.1 of MARPOL Annex VI (Y/N)	**Sailing in ice condition (Y/N)	**STS Operation (Y/N)	Fuel consumption (metric tons)							
							total mass		**mass to be deducted from the total					
									consumed for production of electrical power($FC_{electrical}$)		consumed by oil-fired boiler for cargo heating/discharge on tankers (FC_{boiler})		consumed by standalone engine driven cargo pumps during discharge operations on tankers(FC_{others})	
							***DO/GO	…	DO/GO	…	DO/GO	…	DO/GO	…
01/01/2023 00:00	01/01/2023 13:20	150	13:20	N	N	N								
01/01/2023 13:20	01/01/2023 24:00	60	10:40	N	Y	N								
02/01/2023 00:00	02/01/2023 24:00	288	24:00	N	N	Y								
03/01/2023 00:00	03/01/2023 24:00	260	24:00	N	N	Y								
……	……	……	……	……	……	……								
……	……	……	……	……	……	……								
31/12/2023 00:00	31/12/2023 24:00	290	24:00	N	N	N								
Annual total														

* In the case of daily underlying data, this column would be left blank.
** Refer to the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)*, adopted by resolution MEPC.355(78). Supporting documentation may be additionally submitted to facilitate the verification when necessary, such as Baplie files where the number of in-use reefer containers on board are recorded. Note that voyages in different sailing or operational conditions should be recorded in separate rows so that the correction factors and voyage adjustments can be duly calculated and verified.
*** Refer to fuel types specified in the *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.308(73), as may be amended)

Explanatory remarks: If bunker supply/correction data have been recorded in a company's electronic reporting system, the data is acceptable to be submitted in the existing format instead of submitting the data by this format.

APPENDIX 2 – ADD.1

SAMPLE OF THE COLLECTED DATA SUMMARIES TO CALCULATE TRIAL CII ON A VOLUNTARY BASIS

The following aggregated data should be additionally included in the table in appendix 2, if one or more trial CII metrics have been applied on a voluntary basis:

Date from (dd/mm/yyyy)	*Date to (dd/mm/yyyy)	Laden distance travelled (n.m)	****Transport work (metric of transport work)
01/01/2023			
02/01/2023			
03/01/2023			
31/12/2023			
Annual total			

* In the case of daily underlying data, this column would be left blank.
**** As defined in section 3 of the *Guidelines for voluntary use of the ship energy efficiency operational indicator (EEOI)* circulated by MEPC.1/Circ.684.

Explanatory remarks: If bunker supply/correction data have been recorded in a Company's electronic reporting system, the data is acceptable to be submitted in the existing format instead of submitting the data by this format.

APPENDIX 3

SAMPLE OF THE AGGREGATED DATA BEFORE A TRANSFER OF FLAG/COMPANY ADDRESSED IN REGULATIONS 27.4, 27.5 OR 27.6 OF MARPOL ANNEX VI

Date of transfer (dd/mm/yyyy)	Type of transfer (flag/ company/ both)	Reporting period		Distance Travelled (n.m)		Hours under way (hh:mm)	Fuel consumption (metric tons)					
		Date from (dd/mm/yyyy)	Date to (dd/mm/yyyy)	Total distance travelled	*distance to be deducted from CII calculation		total mass		*mass to be deducted from the total		**mass consumed in STS operations	
							***DO/GO	…	DO/GO	…	DO/GO	…
12/05/2023	Flag	01/01/2023	11/05/2023									
15/06/2023	Company	12/05/2023	14/06/2023									
02/11/2023	Both	15/06/2023	01/11/2023									
……												

* Refer to the aggregated mass of fuel consumption to calculate FC_{voyage}, $FC_{electrical}$, FC_{boiler} and FC_{others} in the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)*, (resolution MEPC.355(78).
** Refer to the aggregated mass of fuel consumption to calculate $AF_{Tanker,STS}$ in the *2022 Interim guidelines on correction factors and voyage adjustments for CII calculations (G5)*, (resolution MEPC.355(78).
*** Refer to fuel types specified in *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.308(73), as may be amended).

APPENDIX 3 – ADD.1

SAMPLE OF THE AGGREGATED DATA BEFORE A TRANSFER OF FLAG/COMPANY ADDRESSED IN REGULATIONS 27.4, 27.5 OR 27.6 OF MARPOL ANNEX VI TO CALCULATE TRIAL CII METRICS ON A VOLUNTARY BASIS

The following aggregated data may be additionally included in the table in appendix 3, if one or more trial CII metrics have been applied on a voluntary basis:

Date of transfer (dd/mm/yyyy)	Type of transfer (flag/ company/ both)	Reporting period		Laden dstance travelled (n.m)	****Transport work (metric of transport work)
		Date from (dd/mm/yyyy)	Date to (dd/mm/yyyy)		
12/05/2023	Flag	01/01/2023	11/05/2023		
15/06/2023	Company	12/05/2023	14/06/2023		
02/11/2023	Both	15/06/2023	01/11/2023		
……					

**** As defined in section 3 of *Guidelines for voluntary use of the ship energy efficiency operational indicator (EEOI)* circulated by MEPC.1/Circ.684.

***

ANNEX 11

RESOLUTION MEPC.349(78)
(adopted on 10 June 2022)

2022 GUIDELINES FOR THE DEVELOPMENT AND MANAGEMENT OF THE IMO SHIP FUEL OIL CONSUMPTION DATABASE

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee, at its seventy-sixth session, adopted, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING ALSO that regulation 27.12 of MARPOL Annex VI specifies that the Secretary-General of the Organization shall maintain an anonymized database such that identification of a specific ship will not be possible,

NOTING FURTHER that regulation 27.13 of MARPOL Annex VI requires that the IMO Ship Fuel Oil Consumption Database be undertaken and managed by the Secretary-General of the Organization, pursuant to guidelines developed by the Organization,

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

NOTING that the Committee, at its seventy-first session, adopted, by resolution MEPC.293(71), the *2017 Guidelines the development and management of the IMO Ship Fuel Oil Consumption Database,*

HAVING CONSIDERED, at its seventy-eighth session, draft *2022 Guidelines for the development and management of the IMO Ship Fuel Oil Consumption Database*,

1 ADOPTS the *2022 Guidelines for the development and management of the IMO Ship Fuel Oil Consumption Database*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 27 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulations 25.3 and 28.11 of MARPOL Annex VI a review of the technical and operational measures to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2017 Guidelines the development and management of the IMO Ship Fuel Oil Consumption Database* adopted by resolution MEPC.293(71).

ANNEX

2022 GUIDELINES FOR THE DEVELOPMENT AND MANAGEMENT OF THE IMO SHIP FUEL OIL CONSUMPTION DATABASE

1 INTRODUCTION

1.1 These Guidelines provide guidance on the development and management of the IMO Ship Fuel Oil Consumption Database (hereafter "the database"), and describe methods that will be used to anonymize ship data for use by Parties, in accordance with regulation 27 of MARPOL Annex VI, and to ensure the completeness of the database.

1.2 In general, the purpose of the database is to provide data for establishing annual CO_2 emissions from ships and support consideration of further measures for reducing carbon intensity of international shipping.

1.3 With regard to data confidentiality, regulation 27.12 stipulates that "The Secretary-General of the Organization shall maintain an anonymized database such that identification of a specific ship will not be possible. Parties shall have access to the anonymized data strictly for their analysis and consideration." These Guidelines balance data anonymization with the usability of data for analysis by the Parties and Organization.

1.4 Regulation 27.13 states that "The IMO Ship Fuel Oil Consumption Database shall be undertaken and managed by the Secretary-General of the Organization, pursuant to guidelines to be developed by the Organization." With regard to the establishment of the database and for data visualization, it will be developed as a module within the Global Integrated Shipping Information System (GISIS) platform and associated web application, as necessary, with the integrated IMO Web Accounts framework utilized to manage secure access to the module.

2 DEFINITIONS

For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

3 DATA ANONYMIZATION

Pursuant to regulation 27.12 of MARPOL Annex VI, the data are to be anonymized such that identification of a specific ship will not be possible. For the purpose of the anonymization of the fuel oil consumption data, the following should apply for the database:

.1 the IMO number and ship flag should not be shown;

.2 gross tonnage (GT), net tonnage (NT), deadweight tonnage (DWT) and power output (rated power) should be rounded to two significant digits, for example, a ship tonnage of 167,430 GT should be shown as 170,000 GT;

.3 attained EEDI and attained EEXI should be rounded to two decimal places;

.4 required annual operational CII (AER or cgDIST), attained annual operational CII (AER or cgDIST), attained annual operational CII (AER or cgDIST) before any correction and operational carbon intensity indicators for trial purpose on voluntary basis (e.g. EEPI, cbDIST, clDIST and EEOI)[1] should be rounded to one decimal place;

[1] Refer to *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII guidelines, G1)* (resolution MEPC.352(78)).

.5 the annual data of fuel oil consumption, distance travelled and hours under way should be provided in full without modification;

.6 ship types other than those defined in regulation 2 should be shown as "others"; and

.7 ice class should be shown as "Yes" or "No".

4 DATA SUBMISSION AND ACCESS

4.1 An Administration should be able to log in to the online database to submit its data via an online form. The data input into the database should be checked by the database system to ensure that the data are being submitted in the standardized format and be cross-referenced with the data from the Ship Particulars module of GISIS.

4.2 The Administration should designate a contact person for the purposes of the database who is responsible for communication with the Secretariat if any matter arises with regard to the submission of data by the respective Administration.

4.3 To encourage the consistent submission of data and improve the usability of the database, automatic notifications and reminders concerning data submission, modification and database update could be incorporated as features in the database.

4.4 An Administration will have access to non-anonymized data of ships flying its flag. Furthermore, the Administration of a ship, to which regulation 28 of MARPOL Annex VI applies, will have access to all reported data for the preceding calendar year for that ship regardless of flag history.

4.5 An Administration should be able to log in to the online database to download the anonymized dataset.

5 MEASURES TO ENSURE THE COMPLETENESS OF THE DATABASE

In accordance with the requirements of regulation 27.10 of MARPOL Annex VI concerning reporting of the status of missing data, the Secretary-General should:

.1 at the beginning of each calendar year, produce a list of ships falling under the scope of regulation 27 by cross-referencing with the data from the Ship Particulars module of GISIS;

.2 send the aforementioned list of ships to the Administration for reference, in order to receive feedback in case of any discrepancies;

.3 check the completeness of the database by comparing the list produced under .1 with the reported data;

.4 remind Administrations which have failed to submit the data in the required form;

.5 report the status of missing data to the Committee on an annual basis; and

.6 request non-reporting Administrations to submit the data of all their registered ships falling under the scope of regulation 27.

6 ANNUAL REPORT TO THE MARINE ENVIRONMENT PROTECTION COMMITTEE

Regulation 27.10 states that "the Secretary-General of the Organization shall produce an annual report to the Marine Environment Protection Committee summarizing the data collected, the status of missing data, and such other relevant information as may be requested by the Committee." At a minimum, each annual report should include the following and also any other information as requested by the Committee:

.1 an aggregated annual amount of each type of fuel oil consumed by all ships of 5,000 GT and above engaged on international voyages;

.2 the aggregated annual amount of each type of fuel oil consumed, distance travelled and hours under way for ships of 5,000 GT and above engaged on international voyages, by ship type and size category as defined in MARPOL Annex VI[2], including the "other" category for ships not defined in MARPOL Annex VI regulation 2;

.3 the number of ships of 5,000 GT and above engaged on international voyages reported to the database, by ship type and size category as defined in MARPOL Annex VI[2]. including the "other" category for ships not defined in MARPOL Annex VI regulation 2;

.4 the number of ships of 5,000 GT and above engaged on international voyages registered with the Party of Annex VI for which data was not received, by ship type and size category as defined in MARPOL Annex VI[2], including the "other" category for ships not defined in MARPOL Annex VI regulation 2; and

.5 the annual development in operational carbon intensity of the ship types and international shipping, as well as the uncertainties in the data and results, using both demand-based measurement and supply-based measurement, as stated in paragraph 1.5 of the *2021 Guidelines on the operational carbon intensity reduction factors relative to reference lines (CII reduction factors guidelines, G3)*.

***

[2] In order to facilitate year-over-year comparison, the Secretariat may also consider using ship type and size categories as used in the Fourth IMO GHG Study 2020, as appropriate.

ANNEX 12

RESOLUTION MEPC.350(78)
(adopted on 10 June 2022)

2022 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, at its seventy-sixth session, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 23 of MARPOL Annex VI requires that the attained Energy Efficiency Existing Ship Index (EEXI) shall be calculated taking into account the guidelines developed by the Organization,

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

NOTING that, at its seventy-sixth session, the Committee adopted, by resolution MEPC.333(76), the *2021 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI),*

HAVING CONSIDERED, at its seventy-eighth session, the draft *2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI),*

1 ADOPTS the *2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI),* as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 23 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulation 25.3 of

MARPOL Annex VI a review of the technical measure to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2021 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI)* adopted by resolution MEPC.333(76).

ANNEX

2022 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI)

CONTENTS

1 Definitions

1.1 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

1.2 For the purpose of these Guidelines, the definitions in MARPOL Annex VI, as amended, apply.

2 Energy Efficiency Existing Ship Index (EEXI)

2.1 EEXI formula

The attained Energy Efficiency Existing Ship Index (EEXI) is a measure of ship's energy efficiency (g/t*nm) and calculated by the following formula:

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

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

** In case of $P_{PTI(i)} > 0$, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$) to be used for calculation of P_{eff}

Note: This formula may not be applicable to a ship having diesel-electric propulsion, turbine propulsion or hybrid propulsion system, except for cruise passenger ships and LNG carriers.

Ships falling into the scope of EEDI requirement can use their attained EEDI calculated in accordance with the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73), as amended, the "EEDI Calculation Guidelines" hereafter) as the attained EEXI if the value of the attained EEDI is equal to or less than that of the required EEXI.

2.2 Parameters

For calculation of the attained EEXI by the formula in paragraph 2.1, parameters under the EEDI Calculation Guidelines apply, unless expressly provided otherwise. In referring to the aforementioned guidelines, the terminology "EEDI" should be read as "EEXI".

2.2.1 $P_{ME(i)}$; Power of main engines

In cases where overridable Shaft / Engine Power Limitation is installed in accordance with the *2021 Guidelines on the shaft / engine power limit to comply with the EEXI requirements and use of a power reserve* (resolution MEPC.335(76)), $P_{ME(i)}$ is 83% of the limited installed power (MCR_{lim}) or 75% of the original installed power (MCR), whichever is lower, for each main engine *(i)*. In cases where the overridable Shaft / Engine Power Limitation and shaft generator(s) are installed, in referring to paragraph 2.2.5.2 (option 1) of the EEDI Calculation Guidelines, "MCR_{ME}" should be read as "MCR_{lim}".

For LNG carriers having steam turbine or diesel electric propulsion, $P_{ME(i)}$ is 83% of the limited installed power (MCR_{lim}, MPP_{lim}), divided by the electrical efficiency in case of diesel electric propulsion system, for each main engine *(i)*. For LNG carriers, the power from combustion of

the excessive natural boil-off gas in the engines or boilers to avoid releasing to the atmosphere or unnecessary thermal oxidation should be deducted from $P_{ME(i)}$ with the approval of the verifier.

2.2.2 $P_{AE(i)}$; Power of auxiliary engines

2.2.2.1 $P_{AE(i)}$ is calculated in accordance with paragraph 2.2.5.6 of the EEDI Calculation Guidelines.

2.2.2.2 For ships where power of auxiliary engines (P_{AE}) value calculated by paragraphs 2.2.5.6.1 to 2.2.5.6.3 of the EEDI Calculation Guidelines is significantly different from the total power used at normal seagoing, e.g. in cases 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 the EEDI Calculation Guidelines).

2.2.2.3 In cases where the electric power table is not available, the P_{AE} value may be approximated either by:

.1 annual average figure of P_{AE} at sea from onboard monitoring obtained prior to the EEXI certification;

.2 for cruise passenger ships, approximated value of power of auxiliary engines ($P_{AE,app}$), as defined below:

$$P_{AE,app} = 0.1193 \times GT + 1814.4 \quad [\text{kW}]$$

.3 for ro-ro passenger ships, approximated value of power of auxiliary engines ($P_{AE,app}$), as defined below:

$$P_{AE,app} = 0.866 \times GT^{0.732} \quad [\text{kW}]$$

2.2.3 V_{ref} ; Ship speed

2.2.3.1 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 the *2014 Guidelines on survey and certification of the Energy Efficiency Design Index (EEDI)*, as amended (resolution MEPC.254(67), as amended).

2.2.3.2 For ships not falling into the scope of the EEDI requirement, the ship speed V_{ref} should be obtained from an estimated speed-power curve as defined in the *2022 Guidelines on survey and certification of the attained EEXI* (resolution MEPC.351(78)).

2.2.3.3 For 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 the EEDI draught and the sea condition as specified in paragraph 2.2.2 of the EEDI Calculation Guidelines are included in the sea trial report, the ship speed V_{ref} may be obtained from the sea trial report:

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

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 $V_{S,EEDI}$.

2.2.3.4 For containerships, bulk carriers or tankers not falling into the scope of the EEDI requirement but whose sea trial results, which may have been calibrated by the tank test, under the design load draught and sea condition as specified in paragraph 2.2.2 of the EEDI Calculation Guidelines are included in the sea trial report, the ship speed V_{ref} may be obtained from the sea trial report:

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

where,

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

$DWT_{S,service}$ is the deadweight under the design load draught;

$P_{S,service}$ is the power of the main engine corresponding to $V_{S,service}$;

k is the scale coefficient, which should be:

.1 0.95 for containerships with 120,000 DWT or less;

.2 0.93 for containerships with more than 120,000 DWT;

.3 0.97 for bulk carrier with 200,000 DWT or less;

.4 1.00 for bulk carrier with more than 200,000 DWT;

.5 0.97 for tanker with 100,000 DWT or less; and

.6 1.00 for tanker with more than 100,000 DWT.

2.2.3.5 In cases where 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 obtained from the in-service performance measurement method conducted and verified in accordance with the methods and procedures as specified in the *Guidance on methods, procedures and verification of in-service performance measurements* (MEPC.1/Circ.901).

2.2.3.6 In cases where 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 approximated by $V_{ref,app}$ to be obtained from statistical mean of distribution of ship speed and engine power, as defined below:

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

For LNG carriers having diesel electric propulsion system and cruise passenger ships having non-conventional propulsion,

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

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:

$$V_{ref,avg} = A \times B^C$$

where

A, B and C are the parameters given in the appendix;

m_V is a performance margin of a ship, which should be 5% of $V_{ref,avg}$ or one knot, whichever is lower; 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 follows:

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

where

D, E and F are the parameters given in the appendix;

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

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

For LNG carriers having diesel electric propulsion system and cruise passenger ship having non-conventional propulsion, the ship speed V_{ref} approximated by $V_{ref,app}$ should be calculated as follows:

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

2.2.3.7 Notwithstanding the above, in cases where the energy-saving device* is installed, the effect of the device may be reflected in the ship speed V_{ref} with the approval of the verifier, based on the 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; and/or

.3 dedicated model tests; and/or

* Devices that shift the power curve, which results in the change of P_P and V_{ref}, as specified in MEPC.1/Circ.896 on *2021 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI and EEXI*.

.4 numerical calculations.

2.2.4 *SFC*; Certified specific fuel consumption

In cases where overridable Shaft / Engine Power Limitation is installed, the *SFC* corresponding to the P_{ME} should be interpolated by using *SFC*s listed in an applicable test report included in an approved NO_x Technical File of the main engine as defined in paragraph 1.3.15 of the NO_x Technical Code.

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 test report included in the NO_X Technical File 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:

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

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

2.2.5 C_F ; Conversion factor between fuel consumption and CO_2 emission

For those engines which do not have a test report included in the NO_x Technical File and which do not have the *SFC* specified by the manufacturer, the C_F corresponding to SFC_{app} should be defined as follows:

$C_F = 3.114\ [t \cdot CO_2/t \cdot Fuel]$ for diesel ships (incl. HFO use in practice)

Otherwise, paragraph 2.2.1 of the EEDI Calculation Guidelines applies.

2.2.6 Correction factor for ro-ro cargo and ro-ro passenger ships (f_{jRoRo})

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:

$$F_{n_L} = \frac{0.5144 \cdot V_{ref,F}}{\sqrt{L_{pp} \cdot g}}$$

where $V_{ref,F}$ is the ship design speed corresponding to 75% of MCR_{ME}.:

and the exponents α, β, γ and δ are defined as follows:

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

2.2.7 Cubic capacity correction factor for ro-ro cargo ships (vehicle carrier) ($f_{cVEHICLE}$)

For ro-ro cargo ships (vehicle carrier) having a DWT/GT ratio of less than 0.35, the following cubic capacity correction factor, $f_{cVEHICLE}$, should apply:

$$f_{cVEHICLE} = \left(\frac{\left({}^{DWT}/_{GT} \right)}{0.35} \right)^{-0,8}$$

Where DWT is the capacity and GT is the gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, annex I, regulation 3.

APPENDIX

Parameters to calculate $V_{ref,avg}$

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

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

Calculation of parameters to calculate $V_{ref,avg}$ and MCR_{avg}

Data sources

1 IHS Fairplay (IHSF) database with the following conditions are used.

Ship type	Ship size	Delivered period	Type of propulsion systems	Population
Bulk carrier	≥ 10,000 DWT	From 1 January 1999 to 1 January 2009	Conventional	2,433
Gas carrier	≥ 2,000 DWT		Conventional	292
Tanker	≥ 4,000 DWT		Conventional	3,345
Containership	≥ 10,000 DWT		Conventional	2,185
General cargo ship	≥ 3,000 DWT		Conventional	1,673
Refrigerated cargo carrier	≥ 3,000 DWT		Conventional	53
Combination carrier	≥ 4,000 DWT		Conventional	3,351
LNG carrier	≥ 10,000 DWT		Conventional, Non-conventional	185
Ro-ro cargo ship (vehicle carrier)	≥ 10,000 DWT		Conventional	301
Ro-ro cargo ship	≥ 1,000 DWT	From 1 January 1998 to 31 December 2010	Conventional	188
Ro-ro passenger ship	≥ 250 DWT		Conventional	350
Cruise passenger ship having non-conventional propulsion	≥ 25,000 GT	From 1 January 1999 to 1 January 2009	Non-conventional	93

2 Data sets with blank/zero "Service speed", "Capacity" and/or Total kW of M/E" are removed.

3 Ship type is in accordance with table 1 and table 2 of resolution MEPC.231(65) on *2013 Guidelines for calculation of reference lines for use with the Energy Efficiency Design Index (EEDI)*. However, "Gas carrier" does not include "LNG carrier". Parameters for "LNG carrier" are given separately.

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ANNEX 13

RESOLUTION MEPC.351(78)
(adopted on 10 June 2022)

2022 GUIDELINES ON SURVEY AND CERTIFICATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, at its seventy-sixth session, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 5.4 (Surveys) of MARPOL Annex VI requires that ships to which chapter 4 applies shall also be subject to survey and certification taking into account guidelines developed by the Organization,

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

NOTING that, at its seventy-sixth session, the Committee adopted, by resolution MEPC.334(76), the *2021 Guidelines on survey and certification of the attained Energy Efficiency Existing Ship Index (EEXI),*

HAVING CONSIDERED, at its seventy-eighth session, draft amendments to the *2021 Guidelines on survey and certification of the attained Energy Efficiency Existing Ship Index (EEXI),*

1 ADOPTS the *2022 Guidelines on survey and certification of the attained Energy Efficiency Existing Ship Index (EEXI),* as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 5 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulation 25.3 of MARPOL Annex VI a review of the technical measure to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2021 Guidelines on survey and certification of the attained Energy Efficiency Existing Ship Index (EEXI),* adopted by resolution MEPC.334(76).

ANNEX

2022 GUIDELINES ON SURVEY AND CERTIFICATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI)

Table of contents

1 GENERAL

The purpose of these Guidelines is to assist verifiers of the Energy Efficiency Existing Ship Index (EEXI) of ships in conducting the survey and certification of the EEXI, in accordance with regulations 5, 6, 7, 8 and 9 of MARPOL Annex VI, and assist shipowners, shipbuilders, manufacturers and other interested parties in understanding the procedures for the survey and certification of the EEXI.

2 DEFINITIONS[1]

2.1 *Verifier* means an Administration, or organization duly authorized by it, which conducts the survey and certification of the EEXI in accordance with regulations 5, 6, 7, 8 and 9 of MARPOL Annex VI and these Guidelines.

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

2.3 *Tank test* means model towing tests, model self-propulsion tests and model propeller open water tests. Numerical calculations may be accepted as equivalent to model propeller open water tests or used to complement the tank tests conducted (e.g. to evaluate the effect of additional hull features such as fins, etc. on ships' performance), or as a replacement for model tests provided that the methodology and numerical model used have been validated/calibrated against parent hull sea trials and/or model tests, with the approval of the verifier.

2.4 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

2.5 For the purpose of these Guidelines, the definitions in MARPOL Annex VI, as amended, apply.

3 APPLICATION

These Guidelines should be applied to ships for which an application for a survey for verification of the ship's EEXI specified in regulation 5 of MARPOL Annex VI has been submitted to a verifier.

4 PROCEDURES FOR SURVEY AND CERTIFICATION

4.1 General

4.1.1 The attained EEXI should be calculated in accordance with regulation 23 of MARPOL Annex VI and the *2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI)* (resolution MEPC.350(78)) (EEXI Calculation Guidelines).

4.1.2 The *2021 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI and EEXI* (MEPC.1/Circ.896) should be applied for calculation of the attained EEXI, if applicable.

[1] Other terms used in these Guidelines have the same meaning as those defined in the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73), as amended) and the *2022 Guidelines on the method of calculation of the attained Energy Efficiency Existing Ship Index (EEXI)* (resolution MEPC.350(78)).

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

4.2 Verification of the attained EEXI

4.2.1 For verification of the attained EEXI, an application for a survey and an EEXI Technical File containing the necessary information for the verification and other relevant background documents should be submitted to a verifier, unless the attained EEDI of the ship satisfies the required EEXI.

4.2.2 The EEXI Technical File should be written at least in English. The EEXI Technical File should include, but not be limited to:

.1 deadweight (DWT) or gross tonnage (GT) for ro-ro passenger ship and cruise passenger ship having non-conventional propulsion;

.2 the rated installed power (*MCR*) of the main and auxiliary engines;

.3 the limited installed power (MCR_{lim}) in cases where the overridable Shaft/Engine Power Limitation system is installed;

.4 the ship speed (V_{ref});

.5 the approximate ship speed ($V_{ref,app}$) for pre-EEDI ships in cases where the speed-power curve is not available, as specified in paragraph 2.2.3.5 of the EEXI Calculation Guidelines;

.6 an approved speed-power curve under the EEDI condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines, which is described in the EEDI Technical File, in cases where regulation 22 of MARPOL Annex VI (Attained EEDI) is applied;

.7 an estimated speed-power curve under the EEDI condition, or under a different load draught to be calibrated to the EEDI condition, obtained from tank test and/or numerical calculations, if available;

.8 estimation process and methodology of the power curves, as necessary, including documentation on consistency with the defined quality standards (e.g. ITTC 7.5-03-01-02 and ITTC 7.5-03-01-04 in their latest revisions) and the verification of the numerical set-up with parent hull or the reference set of comparable ships in case of using numerical calculations;

.9 a sea trial report including sea trial results, which may have been calibrated by the tank test, under the sea condition as specified in paragraph 2.2.2 of the EEDI Calculation Guidelines, if available;

.10 an in-service performance measurement report, where applicable, as specified in paragraphs 2.2.3.5 and 2.2.3.7.2 of the EEXI Calculation Guidelines;

.11 calculation process of $V_{ref,app}$ for pre-EEDI ships in cases where the speed-power curve is not available, as specified in paragraph 2.2.3.6 of the EEXI Calculation Guidelines;

.12 type of fuel;

.13 the specific fuel consumption (*SFC*) of the main and auxiliary engines, as specified in paragraph 2.2.4 of the EEXI Calculation Guidelines;

.14 the electric power table[2] for certain ship types, as necessary, as defined in the EEDI Calculation Guidelines;

.15 the documented record of annual average figure of the auxiliary engine load at sea obtained prior to the date of application for a survey for verification of the ship's EEXI, as specified in paragraph 2.2.2.3 of the EEXI Calculation Guidelines, if applicable;

.16 calculation process of $P_{AE,app}$, as specified in paragraph 2.2.2.3 of the EEXI Calculation Guidelines, if applicable;

.17 principal particulars, ship type and the relevant information to classify the ship as such a ship type, classification notations and an overview of the propulsion system and electricity supply system on board;

.18 description of energy-saving equipment, if available;

.19 calculated value of the attained EEXI, including the calculation summary, which should contain, at a minimum, each value of the calculation parameters and the calculation process used to determine the attained EEXI; and

.20 for LNG carriers:

.1 type and outline of propulsion systems (such as direct drive diesel, diesel electric, steam turbine);

.2 LNG cargo tank capacity in m^3 and BOR as defined in paragraph 2.2.5.6.3 of the EEDI Calculation Guidelines;

.3 shaft power of the propeller shaft after transmission gear at 100% of the rated output of motor (MPP_{Motor}) and $\eta_{(i)}$ for diesel electric;

.4 shaft power of the propeller shaft after transmission gear at the de-rated output of motor ($MPP_{Motor,lim}$) in cases where the overridable Shaft / Engine Power Limitation is installed;

.5 maximum continuous rated power ($MCR_{SteamTurbine}$) for steam turbine;

.6 limited maximum continuous rated power ($MCR_{SteamTurbine,lim}$) for steam turbine in cases where the overridable Shaft / Engine Power Limitation is installed; and

[2] Electric power tables should be validated separately, taking into account the guidelines set out in appendix 2 of the *2014 Guidelines on survey and certification of the Energy Efficiency Design Index (EEDI)* (resolution MEPC.254(67), as amended by resolutions MEPC.261(68) and MEPC.309(73)); consolidated text: MEPC.1/Circ.855/Rev.2, as may be further amended).

.7 $SFC_{SteamTurbine}$ for steam turbine, as specified in paragraph 2.2.7.2 of the EEDI Calculation Guidelines. If the calculation is not available from the manufacturer, $SFC_{SteamTurbine}$ may be calculated by the submitter.

A sample of an EEXI Technical File is provided in the appendix.

4.2.3 The *SFC* should be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil, referring to ISO 15550:2002 and ISO 3046-1:2002. For the confirmation of the *SFC*, a copy of the approved NO_x Technical File and documented summary of the correction calculations should be submitted to the verifier.

4.2.4 For ships equipped with dual-fuel engine(s) using LNG and fuel oil, the C_F-factor for gas (LNG) and the specific fuel consumption (*SFC*) of gas fuel should be used by applying the criteria specified in paragraph 4.2.3 of the *2014 Guidelines on survey and certification of the Energy Efficiency Design Index (EEDI)*, as amended,[3] as a basis for the guidance of the Administration.

4.2.5 Notwithstanding paragraphs 4.2.3 and 4.2.4, in cases where overridable Shaft/Engine Power Limitation is installed, or in cases where engines do not have a test report included in the NO_x Technical File, *SFC* should be calculated in accordance with paragraph 2.2.4 of the EEXI Calculation Guidelines. For this purpose, actual performance records of the engine may be used if satisfactory and acceptable to the verifier.

4.2.6 The verifier may request further information from the submitter, as specified in paragraph 4.2.7 of the EEDI Survey and Certification Guidelines, in addition to that contained in the EEXI Technical File, as necessary, to examine the calculation process of the attained EEXI.

4.2.7 In cases where the sea trial report as specified in paragraph 4.2.2.9 is submitted, the verifier should request further information from the submitter to confirm that:

.1 the sea trial was conducted in accordance with the conditions specified in paragraphs 4.3.3, 4.3.4 and 4.3.7 of the EEDI Survey and Certification Guidelines, as applicable;

.2 sea conditions were measured in accordance with ISO 15016:2002 or the equivalent if satisfactory and acceptable to the verifier;

.3 ship speed was measured in accordance with ISO 15016:2002 or the equivalent if satisfactory and acceptable to the verifier; and

.4 the measured ship speed was calibrated, if necessary, by taking into account the effects of wind, tide, waves, shallow water and displacement in accordance with ISO 15016:2002 or the equivalent which may be acceptable provided that the concept of the method is transparent for the verifier and publicly available/accessible.

4.2.8 In cases where the in-service performance measurement report as specified in paragraph 4.2.2.10 is submitted, the verifier should confirm that the in-service performance measurement was conducted and verified in accordance with the methods and procedures as specified in the *Guidance on methods, procedures and verification of in-service performance measurements* (MEPC.1/Circ.901).

[3] Resolution MEPC.254(67), as amended.

4.2.9 The estimated speed-power curve obtained from the tank test and/or numerical calculations and/or the sea trial results calibrated by the tank test should be reviewed on the basis of the relevant documents in accordance with the EEDI Survey and Certification Guidelines, the defined quality standards (e.g. ITTC 7.5-03-01-02 and ITTC 7.5-03-01-04 in their latest revisions) and the verification of the numerical set-up with parent hull or the reference set of comparable ships.

4.2.10 In cases where the overridable Shaft/Engine Power Limitation system is installed, the verifier should confirm that the system is appropriately installed and sealed in accordance with the *2021 Guidelines on the Shaft/Engine Power Limitation system to comply with the EEXI requirements and use of a power reserve* (resolution MEPC.335(76)) and that a verified Onboard Management Manual (OMM) for overridable Shaft/Engine Power Limitation is on board the ship.

4.3 Verification of the attained EEXI in case of major conversion

4.3.1 In cases of a major conversion of a ship taking place at or after the completion date of the survey for EEXI verification specified in regulation 5.4.7 of MARPOL Annex VI, the shipowner should submit to a verifier an application for a general or partial survey with the EEXI Technical File duly revised, based on the conversion made and other relevant background documents.

4.3.2 The background documents should include as a minimum, but are not limited to:

.1 details of the conversion;

.2 EEXI parameters changed after the conversion and the technical justifications for each respective parameter;

.3 reasons for other changes made in the EEXI Technical File, if any; and

.4 calculated value of the attained EEXI with the calculation summary, which should contain, as a minimum, each value of the calculation parameters and the calculation process used to determine the attained EEXI after the conversion.

4.3.3 The verifier should review the revised EEXI Technical File and other documents submitted and verify the calculation process of the attained EEXI to ensure that it is technically sound and reasonable and follows regulation 23 of MARPOL Annex VI and the EEXI Calculation Guidelines.

4.3.4 For verification of the attained EEXI after the major conversion, speed trials of the ship may be conducted, as necessary.

APPENDIX

SAMPLE OF 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 MCR_{ME} 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 2.1.

(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 2.1.

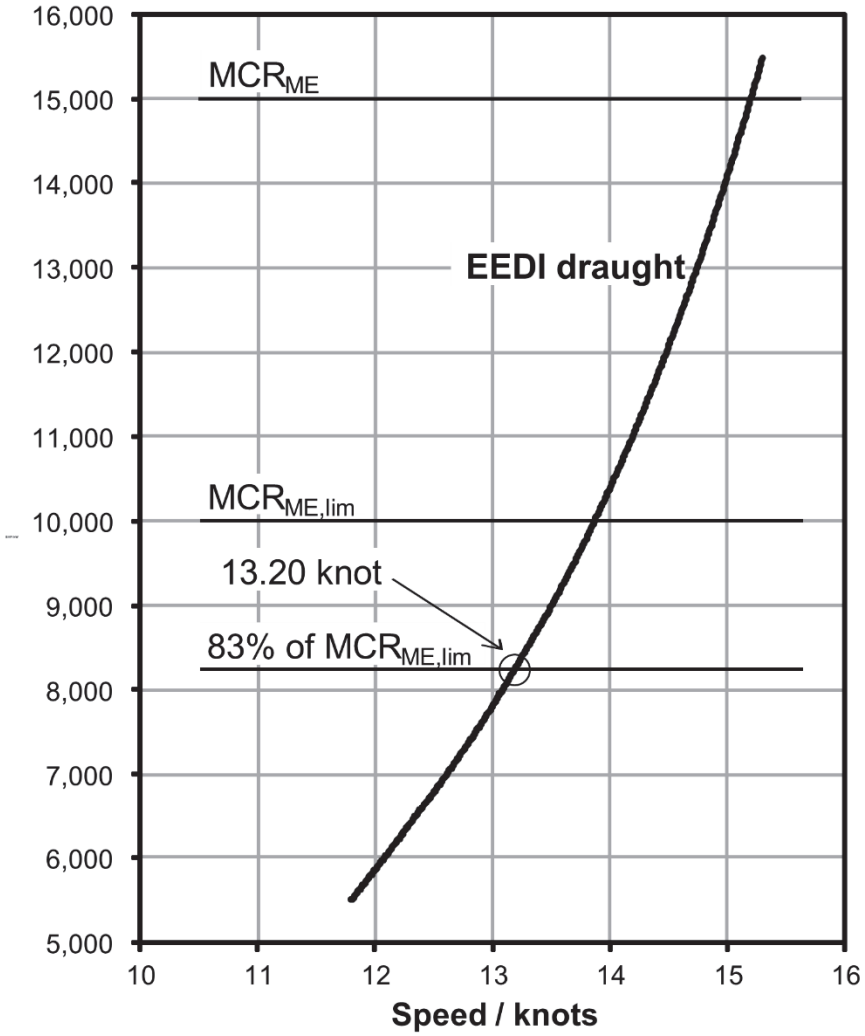

Figure 2.1: Power curve

(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 2.2.

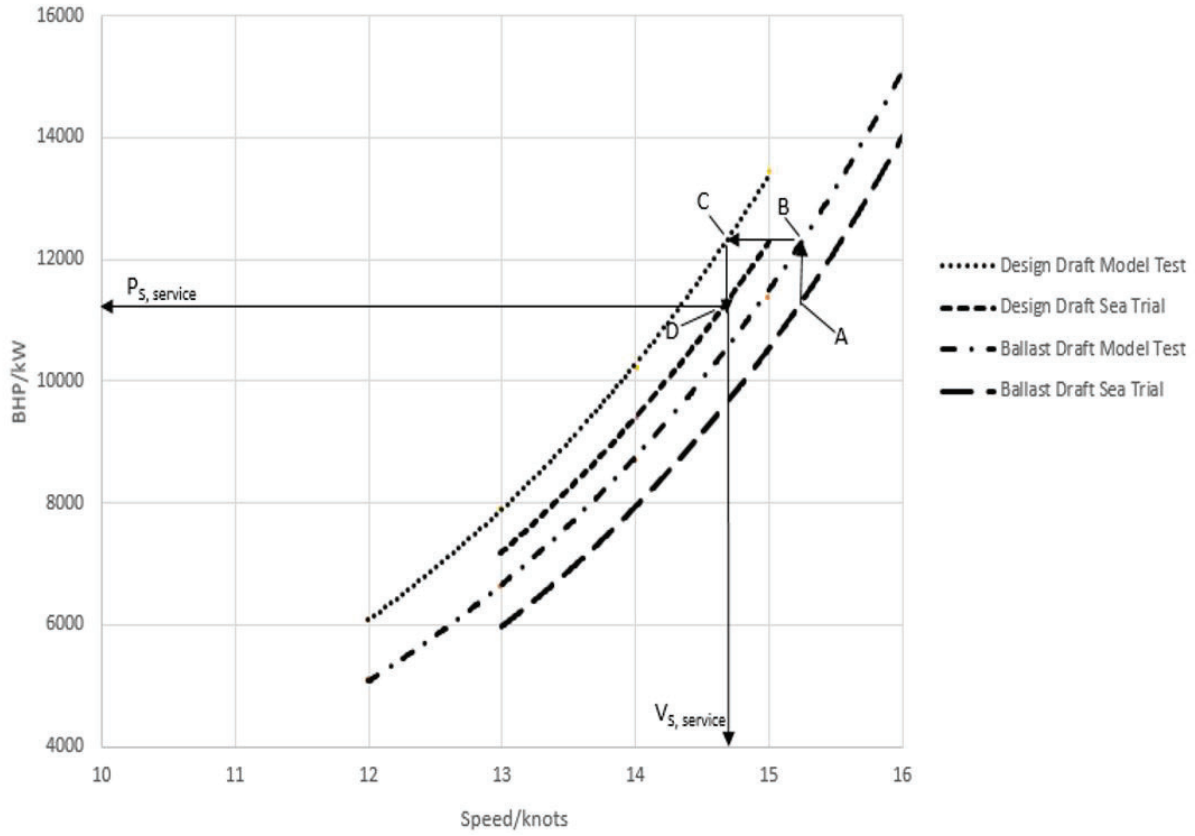

Figure 2.2: Power curve

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

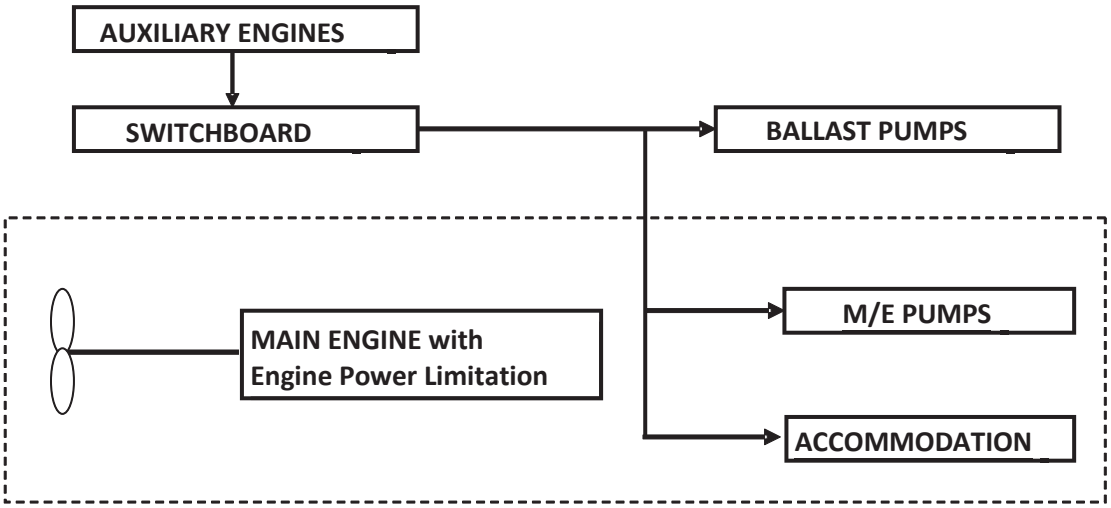

Figure 3.1: Schematic figure of propulsion and electric power supply system

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 below.

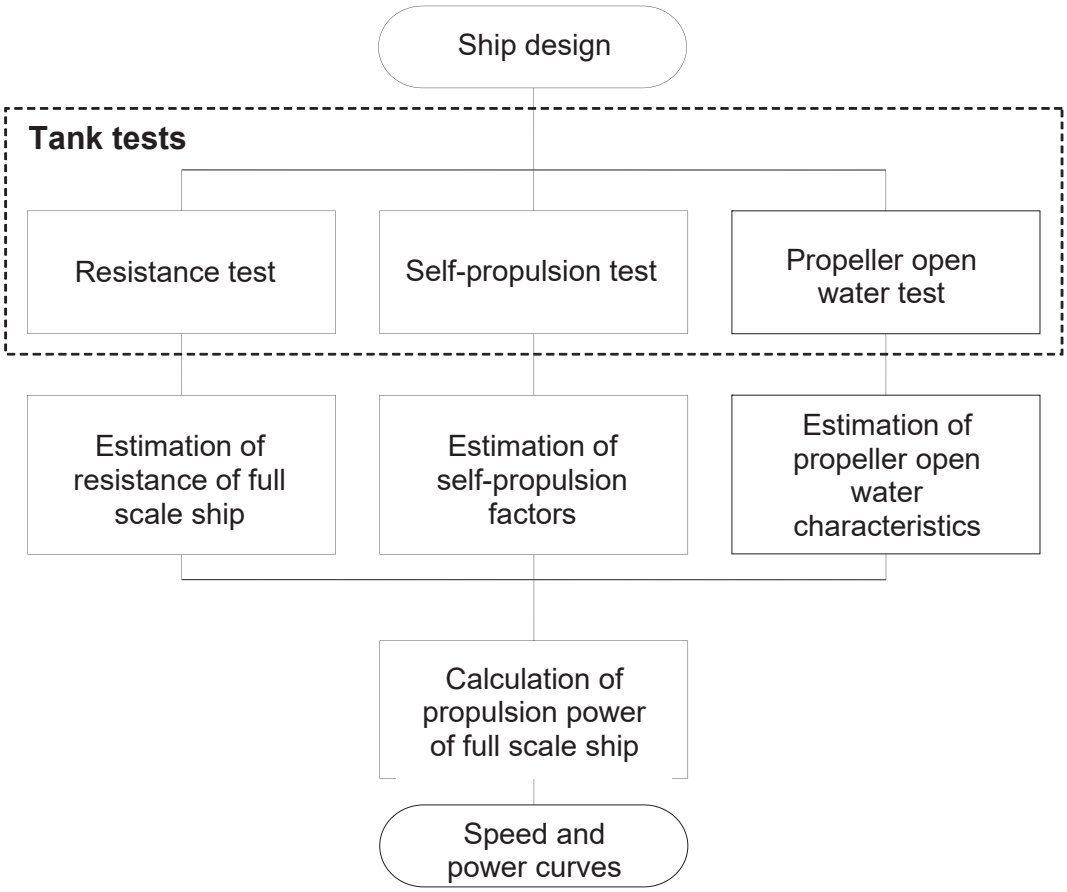

Figure 4: Flow chart of process for estimating speed-power curve from tank tests

5 Description of energy-saving equipment

5.1 Energy-saving equipment the effects of which are expressed as $P_{AEeff(i)}$ and/or $P_{eff(i)}$ 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

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

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

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

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

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

attained EEXI: 2.45 g-CO_2/ton mile

***

ANNEX 14

RESOLUTION MEPC.352(78)
(adopted on 10 June 2022)

2022 GUIDELINES ON OPERATIONAL CARBON INTENSITY INDICATORS AND THE CALCULATION METHODS (CII GUIDELINES, G1)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, at its seventy-sixth session, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 28.1 of MARPOL Annex VI requires ships to which this regulation apply to calculate the attained annual operational CII taking into account the guidelines developed by the Organization,

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

NOTING that the Committee, at its seventy-sixth session, adopted, by resolution MEPC.336(76), the *2021 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1),*

HAVING CONSIDERED, at its seventy-eighth session, the draft *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)*,

1 ADOPTS the *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 28.1 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulation 28.11 of

MARPOL Annex VI a review of the operational measure to reduce carbon intensity of international shipping shall be completed by 1 January 2026,

5 REVOKES the *2021 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)* adopted by resolution MEPC.336(76).

ANNEX

2022 GUIDELINES ON OPERATIONAL CARBON INTENSITY INDICATORS AND THE CALCULATION METHODS (CII GUIDELINES, G1)

1 Introduction

1.1 In the *Initial IMO Strategy on Reduction of GHG Emissions from Ships* (Resolution MEPC.304(72)), the level of ambition on carbon intensity of international shipping is quantified by the CO_2 emissions per transport work, as an average across international shipping.

1.2 These Guidelines address the calculation methods and the applicability of the operational carbon intensity indicator (CII) for individual ships to which chapter 4 of MARPOL Annex VI, as amended, applies.

2 Definitions

2.1 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

2.2 *IMO DCS* means the data collection system for fuel oil consumption of ships referred to in regulation 27 and related provisions of MARPOL Annex VI.

2.3 For the purpose of these Guidelines, the definitions in MARPOL Annex VI, as amended, apply.

2.4 The metrics indicating the average CO_2 emissions per transport work of a ship are generally referred to as operational carbon intensity indicator (CII) in these Guidelines.

.1 A specific CII calculated based on the actual or estimated mass or volume of the shipment carried on board a ship is generally referred to as *demand-based CII*; and

.2 A specific CII, in which calculation the capacity of a ship is taken as proxy of the actual mass or volume of the shipment carried on board, is generally referred to as *supply-based CII*.

2.5 The supply-based CII which uses DWT as the capacity is referred to as *AER*, and the supply-based CII which uses GT as the capacity is referred to as *cgDIST*.

3 Application

3.1 For all ships to which regulation 28 of MARPOL Annex VI applies, the operational carbon intensity indicators defined in section 4 should be applied.

3.2 The operational carbon intensity indicators defined in section 5 are encouraged to be additionally used by ships, where applicable, for trial purposes.

4 Operational carbon intensity indicator (CII) of individual ships for use in implementing regulation 28 of MARPOL Annex VI

In its most simple form, the attained annual operational CII of individual ships is calculated as the ratio of the total mass of CO_2 (*M*) emitted to the total transport work (*W*) undertaken in a given calendar year, as follows:

$$attained\ CII_{ship} = M / W \qquad (1)$$

4.1 Mass of CO_2 emissions (M)

The total mass of CO_2 is the sum of CO_2 emissions (in grams) from all the fuel oil consumed on board a ship in a given calendar year, as follows:

$$M = FC_j \times C_{F_j} \qquad (2)$$

where:

- j is the fuel oil type;
- FC_j is the total mass (in grams) of consumed fuel oil of type j in the calendar year, as reported under IMO DCS; and
- C_{F_j} represents the fuel oil mass to CO_2 mass conversion factor for fuel oil type j, in line with those specified in the *2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships (resolution MEPC.308(73))*, as may be further amended. In case the type of the fuel oil is not covered by the guidelines, the conversion factor should be obtained from the fuel oil supplier supported by documentary evidence.

4.2 Transport work (W)

In the absence of the data on actual transport work, the supply-based transport work (W_s) can be taken as a proxy, which is defined as the product of a ship's capacity and the distance travelled in a given calendar year, as follows:

$$W_s = C \times D_t \qquad (3)$$

where:

- *C* represents the ship's capacity:
  - For bulk carriers, tankers, container ships, gas carriers, LNG carriers, general cargo ships, refrigerated cargo carrier and combination carriers, deadweight tonnage (DWT)[1] should be used as Capacity;
  - For cruise passenger ships, ro-ro cargo ships (vehicle carriers), ro-ro cargo

[1] Deadweight tonnage (DWT) means the difference in tonnes between the displacement of a ship in water of relative density of 1,025 kg/m3 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 stability booklet approved by the Administration or any organization recognized by it.

ships and ro-ro passenger ships, gross tonnage (GT)[2] should be used as Capacity; and

- D_t represents the total distance travelled (in nautical miles), as reported under IMO DCS.

5 Operational carbon intensity indicator (CII) of individual ships for trial purpose

The following metrics are encouraged to be used for trial purposes, where applicable:

.1 Energy Efficiency Performance Indicator (EEPI)

$$EEPI = \frac{M}{C \times D_l}$$

.2 cbDIST

$$cbDIST = \frac{M}{ALB \times D_t}$$

.3 clDIST

$$clDIST = \frac{M}{Lanemeter \times D_t}$$

.4 EEOI, as defined in MEPC.1/Circ.684 on *Guidelines for voluntary use of the ship energy efficiency operational indicator (EEOI).*

In the formulas above:

- the mass of CO_2 (M), the ship's capacity (C) and the total distance travelled (D_t) are identical with those used to calculate the attained CII of individual ships, as specified in section 4.1 and 4.2;
- D_l means the laden distance travelled (in nautical miles) when the ship is loaded;
- *ALB* means the number of available lower berths of a cruise passenger ship; and
- *Lanemeter* means the length (in metres) of the lanes of a ro-ro ship.

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[2] Gross tonnage (GT) should be calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969.

ANNEX 15

RESOLUTION MEPC.353(78)
(adopted on 10 June 2022)

2022 GUIDELINES ON THE REFERENCE LINES FOR USE WITH OPERATIONAL CARBON INTENSITY INDICATORS (CII REFERENCE LINES GUIDELINES, G2)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, at its seventy-sixth session, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 28.4 of MARPOL Annex VI requires reference lines to be established for each ship type to which regulation 28 is applicable,

NOTING that the Committee, at its seventy-sixth session, adopted, by resolution MEPC.337(76), *2021 Guidelines on the reference lines for use with operational carbon intensity indicators (CII Reference Lines Guidelines, G2)*

HAVING CONSIDERED, at its seventy-eighth session, the draft *2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII reference lines guidelines, G2)*,

1 ADOPTS the *2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII reference lines guidelines, G2)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 28.4 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulation 28.11 of MARPOL Annex VI a review of the operational measures to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2021 Guidelines on the reference lines for use with operational carbon intensity indicators (CII Reference Lines Guidelines, G2)*.

ANNEX

2022 GUIDELINES ON THE REFERENCE LINES FOR USE WITH OPERATIONAL CARBON INTENSITY INDICATORS (CII REFERENCE LINES GUIDELINES, G2)

1 Introduction

1.1 These Guidelines provide the methods to calculate the reference lines for use with operational carbon intensity indicators, and the ship type specific carbon intensity reference lines as referred to in regulation 28 of MARPOL Annex VI.

1.2 One reference line is developed for each ship type to which regulation 28 of MARPOL Annex VI applies, based on the specific indicators stipulated in *2022 Guidelines on operational carbon intensity indicators and the calculation methods* (G1) developed by the Organization, ensuring that only data from comparable ships are included in the calculation of each reference line.

2 Definition

2.1 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

2.2 *IMO DCS* means the data collection system for fuel oil consumption of ships referred to in regulation 27 and related provisions of MARPOL Annex VI.

2.3 For the purpose of these Guidelines, the definitions in MARPOL Annex VI, as amended, apply.

2.4 An operational carbon intensity indicator (CII) reference line is defined as a curve representing the median attained operational carbon intensity performance, as a function of Capacity, of a defined group of ships in year of 2019.

3 Method to develop the CII reference lines

3.1 Given the limited data available for the year of 2008, the operational carbon intensity performance of ship types in year 2019 is taken as the reference.

3.2 For a defined group of ships, the reference line is formulated as follows:

$$\boldsymbol{CII_{ref} = aCapacity^{-c}} \qquad (1)$$

where CII_{ref} is the reference value of year 2019, $Capacity$ is identical with the one defined in the specific carbon intensity indicator (CII) for a ship type, as shown in Table. 1; *a* and *c* are parameters estimated through median regression fits, taking the attained CII and the Capacity of individual ships collected through IMO DCS in year 2019 as the sample.

4 Ship type specific operational carbon intensity reference lines

The parameters for determining the ship type specific reference lines, for use in Eq.(1), are specified as follows:

Table 1: Parameters for determining the 2019 ship type specific reference lines

Ship type			Capacity	*a*	*c*
Bulk carrier	279,000 DWT and above		279,000	4745	0.622
	less than 279,000 DWT		DWT	4745	0.622
Gas carrier	65,000 and above		DWT	14405E7	2.071
	less than 65,000 DWT		DWT	8104	0.639
Tanker			DWT	5247	0.610
Container ship			DWT	1984	0.489
General cargo ship		20,000 DWT and above	DWT	31948	0.792
		less than 20,000 DWT	DWT	588	0.3885
Refrigerated cargo carrier			DWT	4600	0.557
Combination carrier			DWT	5119	0.622
LNG carrier	100,000 DWT and above		DWT	9.827	0.000
	65,000 DWT and above, but less than 100,000 DWT		DWT	14479E10	2.673
	less than 65,000 DWT		65,000	14779E10	2.673
Ro-ro cargo ship (vehicle carrier)		57,700 GT and above	57,700	3627	0.590
		30,000 GT and above, but less than 57,700 GT	GT	3627	0.590
		Less than 30,000 GT	GT	330	0.329
Ro-ro cargo ship			GT	1967	0.485
Ro-ro passenger ship		Ro-ro passenger ship	GT	2023	0.460
		High-speed craft designed to SOLAS chapter X	GT	4196	0.460
Cruise passenger ship			GT	930	0.383

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ANNEX 16

RESOLUTION MEPC.354(78)
(adopted on 10 June 2022)

2022 GUIDELINES ON THE OPERATIONAL CARBON INTENSITY RATING OF SHIPS (CII RATING GUIDELINES, G4)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee adopted, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI*, which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING FURTHER that regulation 28.6 of MARPOL Annex VI requires ships to which this regulation apply to determine operational carbon intensity rating taking into account guidelines developed by the Organization,

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

NOTING that, at its seventy-sixth session, the Committee adopted, by resolution MEPC.339(76) the *2021 Guidelines on the operational carbon intensity rating of ships (CII rating guidelines, G4)*,

HAVING CONSIDERED, at its seventy-eighth session, draft *2022 Guidelines on the operational carbon intensity rating of ships (CII rating guidelines, G4)*,

1 ADOPTS the *2022 Guidelines on the operational carbon intensity rating of ships (CII rating guidelines, G4)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 28.6 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, of additional data collected and analysed, also taking into consideration that

in accordance with regulation 28.11 of MARPOL Annex VI a review of the operational measure to reduce carbon intensity of international shipping shall be completed by 1 January 2026;

5 REVOKES the *2021 Guidelines on the operational carbon intensity rating of ships (CII rating guidelines, G4)*, adopted by resolution MEPC.339(76).

ANNEX

2022 GUIDELINES ON THE OPERATIONAL CARBON INTENSITY RATING OF SHIPS (CII RATING GUIDELINES, G4)

1 Introduction

1.1 These Guidelines provide the methods to assign operational energy efficiency performance ratings to ships, as referred to in regulation 28 of MARPOL Annex VI. On this basis, the boundaries for determining a ship's annual operational carbon intensity performance from year 2023 to 2030 are also provided.

2 Definitions

2.1 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

2.2 *IMO DCS* means the data collection system for fuel oil consumption of ships referred to in regulation 27 and related provisions of MARPOL Annex VI.

2.3 For the purpose of these Guidelines, the definitions in MARPOL Annex VI, as amended, apply.

2.4 *Operational carbon intensity rating* means to assign a ranking label from among the five grades (A, B, C, D and E) to the ship based on the attained annual operational carbon intensity indicator, indicating a major superior, minor superior, moderate, minor inferior, or inferior performance level.

3 Framework of the operational energy efficiency performance rating

3.1 An operational energy efficiency performance rating should be assigned annually to each ship to which regulation 28 of MARPOL Annex VI applies, in a transparent and robust manner, based on the deviation of the attained annual operational carbon intensity indicator (CII) of a ship from the required value.

3.2 To facilitate the rating assignment, for each year from 2023 to 2030, four boundaries are defined for the five-grade rating mechanism, namely superior boundary, lower boundary, upper boundary, and inferior boundary. Thus, a rating can be assigned through comparing the attained annual operational CII of a ship with the boundary values.

3.3 The boundaries are set based on the distribution of CIIs of individual ships in year 2019. The appropriate rating boundaries are expected to generate the following results: the middle 30% of individual ships across the fleet segment, in terms of the attained annual operational CIIs, are to be assigned rating C, while the upper 20% and further upper 15% of individuals are to be assigned rating D and E respectively, and the lower 20% and further lower 15% of the individuals are to be assigned rating B and A, respectively, as illustrated in figure 1.

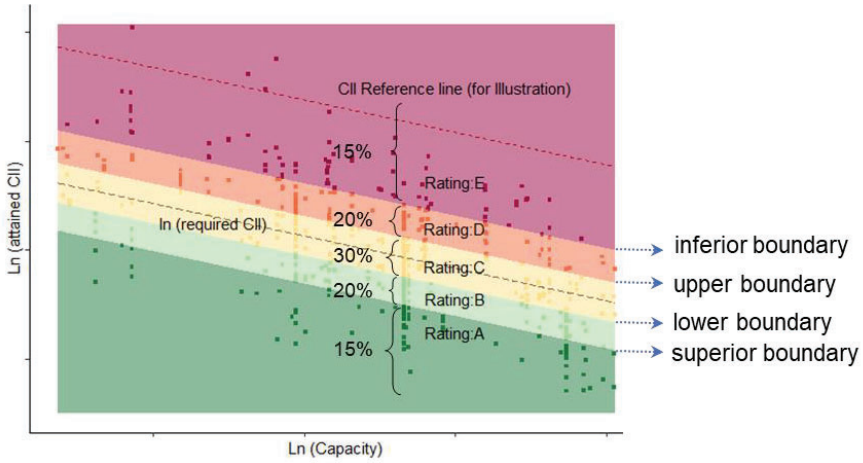

Figure 1: Operational energy efficiency performance rating scale

3.4 Given the incremental operational carbon intensity reduction factors over time, the boundaries for defining performance ratings should be synchronized accordingly, although the relative distance between the boundaries should not change. The rating of a ship would be determined by the attained CII and the predetermined rating boundaries, rather than the attained CII of other ships. Note that the distribution of ship individual ratings in a specific year may not be always identical with the scenario in 2019, where for example 20% may achieve A, 30% may achieve B, 40% may achieve C, 8% may achieve D and 2% may achieve E in a given year.

4 Method to determine the rating boundaries

4.1 The boundaries can be determined by the required annual operational CII in conjunction with the vectors, indicating the direction and distance they deviate from the required value (denoted as dd vectors for easy reference), as illustrated in figure 2.

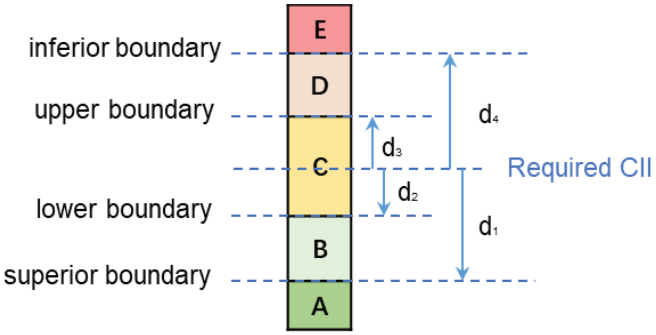

Figure 2: dd vectors and rating bands

4.2 Statistically, the dd vectors depend on the distribution of the attained annual operational CII of ships of the type concerned, which can be estimated through a quantile regression, taking data collected through DCS in year 2019 as the sample.

4.3 The quantile regression model for a specific ship type can be developed as follows:

$$\ln(attained\ CII) = \delta^{(p)} - c\ln(Capacity) + \varepsilon^{(p)}, \quad p = \{0.15, 0.35, 0.50, 0.65, 0.85\} \quad (1)$$

where $Capacity$ is identical with the one used in the operation carbon intensity indicator as specified in the Guidelines on operational carbon intensity indicators and the calculation

methods (G1); p is the typical quantile, meaning the proportion of observations with a lower value is $p\%$; $\delta^{(p)}$ is the constant term, and $\varepsilon^{(p)}$ is the error term.

4.4 The quantile regression lines in logarithm form are illustrated in Fig.3.

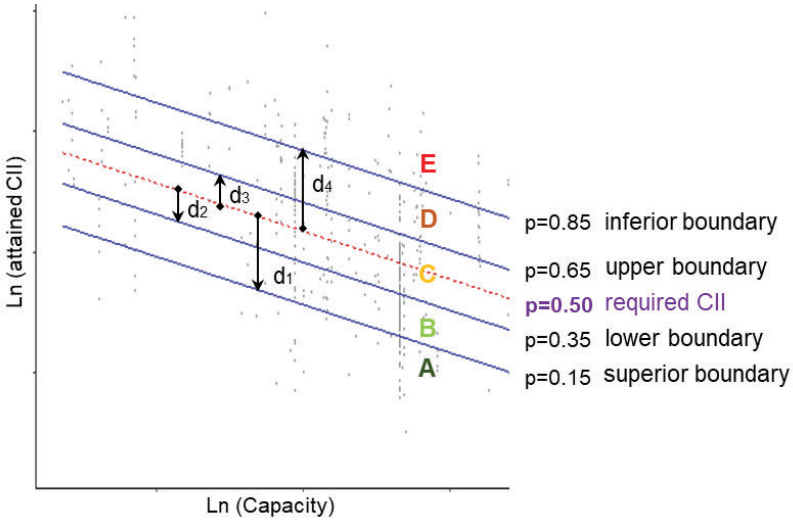

Figure 3: Quantile regression lines in logarithm form

4.5 Then, the dd vectors can be calculated based on the estimates of the intercept ($\hat{\delta}^{(p)}$), in accordance with Eq.(2), as follows:

$$\left.\begin{aligned} d_1 &= \hat{\delta}^{(0.15)} - \hat{\delta}^{(0.50)} \\ d_2 &= \hat{\delta}^{(0.35)} - \hat{\delta}^{(0.50)} \\ d_3 &= \hat{\delta}^{(0.65)} - \hat{\delta}^{(0.50)} \\ d_4 &= \hat{\delta}^{(0.85)} - \hat{\delta}^{(0.50)} \end{aligned}\right\} \quad (2)$$

4.6 Through an exponential transformation of each dd vector, the four boundaries fitted in the original data form can be derived based on the required annual operational carbon intensity indicator ($required\ CII$), as follows:

$$\left.\begin{aligned} \text{superior boundary} &= \exp(d_1) \cdot required\ CII \\ \text{lower boundary} &= \exp(d_2) \cdot required\ CII \\ \text{upper boundary} &= \exp(d_3) \cdot required\ CII \\ \text{inferior boundary} &= \exp(d_4) \cdot required\ CII \end{aligned}\right\} \quad (3)$$

Rating boundaries of ship types

The estimated dd vectors after exponential transformation for determining the rating boundaries of ship types are as follows:

Table 1: *dd* vectors for determining the rating boundaries of ship types

Ship type		Capacity in CII calculation	*dd* vectors (after exponential transformation)			
			exp(d1)	exp(d2)	exp(d3)	exp(d4)
Bulk carrier		DWT	0.86	0.94	1.06	1.18
Gas carrier	65,000 DWT and above	DWT	0.81	0.91	1.12	1.44
	less than 65,000 DWT	DWT	0.85	0.95	1.06	1.25
Tanker		DWT	0.82	0.93	1.08	1.28
Container ship		DWT	0.83	0.94	1.07	1.19
General cargo ship		DWT	0.83	0.94	1.06	1.19
Refrigerated cargo carrier		DWT	0.78	0.91	1.07	1.20
Combination carrier		DWT	0.87	0.96	1.06	1.14
LNG carrier	100,000 DWT and above	DWT	0.89	0.98	1.06	1.13
	less than 100,000 DWT		0.78	0.92	1.10	1.37
Ro-ro cargo ship (vehicle carrier)		GT	0.86	0.94	1.06	1.16
Ro-ro cargo ship		GT	0.76	0.89	1.08	1.27
Ro-ro passenger ship		GT	0.76	0.92	1.14	1.30
Cruise passenger ship		GT	0.87	0.95	1.06	1.16

By comparing the attained annual operational CII of a specific ship with the four boundaries, a rating can then be assigned. For example, given the required CII of a bulk carrier in a specific year as 10 gCO_2/(dwt.nmile), then the superior boundary, lower boundary, upper boundary, and inferior boundary is 8.6, 9.4, 10.6 and 11.8 gCO_2/(dwt.nmile). If the attained CII is 9 gCO_2/(dwt.nmile), the ship would be rated as "B".

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ANNEX 17

RESOLUTION MEPC.355(78)
(adopted on 10 June 2022)

2022 INTERIM GUIDELINES ON CORRECTION FACTORS AND VOYAGE ADJUSTMENTS FOR CII CALCULATIONS (CII GUIDELINES, G5)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

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

NOTING that the Committee, at its seventy-sixth session, adopted, by resolution MEPC.328(76), the *2021 Revised MARPOL Annex VI,* which will enter into force on 1 November 2022,

NOTING IN PARTICULAR that the *2021 Revised MARPOL Annex VI* (MARPOL Annex VI) contains amendments concerning mandatory goal-based technical and operational measures to reduce carbon intensity of international shipping,

NOTING ALSO that regulation 28.1 of MARPOL Annex VI requires ships to which this regulation apply to calculate the attained annual operational carbon intensity indicator (CII) taking into account the guidelines developed by the Organization,

NOTING FURTHER that the in adopting resolution MEPC.336(76) on the *2021 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)*, the Committee agreed to consider substantiated proposals for CII correction factors for certain ship types, operational profiles and/or voyages with a view to enhancing, as appropriate, the CII Guidelines (G1), before entry into force of the aforementioned amendments to MARPOL Annex VI,

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

HAVING CONSIDERED, at its seventy-eighth session, the draft *2022 Interim Guidelines on correction factors and voyage adjustments for CII calculations (CII Guidelines, G5)*,

1 ADOPTS the *2022 Interim Guidelines on correction factors and voyage adjustments for CII calculations (CII Guidelines, G5)*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulation 28.1 of MARPOL Annex VI;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested parties;

4 AGREES to keep the Guidelines under review in light of experience gained with their implementation, also taking into consideration that in accordance with regulation 28.11 of MARPOL Annex VI a review of the operational measure to reduce carbon intensity of international shipping shall be completed by 1 January 2026.

ANNEX

2022 INTERIM GUIDELINES ON CORRECTION FACTORS AND VOYAGE ADJUSTMENTS FOR CII CALCULATIONS (CII GUIDELINES, G5)

CONTENTS

1 Introduction

1.1 These Guidelines address the corrections factors and voyage adjustments which may be applied to the calculation of the attained annual operational carbon intensity indicator (CII_{ship}) of regulation 28 of MARPOL Annex VI, and as defined by the *2022 Guidelines on operational carbon intensity indicators and the calculation methods (CII Guidelines, G1)* (resolution MEPC.352 (78)). It should be noted that the use of correction factors and voyage adjustments should in no way undermine the goal of reducing the carbon intensity of international shipping as set out in regulation 20 of MARPOL Annex VI.

2 Definitions

For the purpose of these Guidelines, the definitions in regulation 2 of MARPOL Annex VI, as amended, apply. In addition and for the scope of these guidelines, the following definitions apply.

2.1 *MARPOL* means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto, as amended.

2.2 *IMO DCS* means the IMO Ship Fuel Oil Consumption Database referred to in regulation 27 and related provisions of MARPOL Annex VI.

2.3 A *voyage period* is a period of time where the ship meets the criteria to apply a voyage adjustment in these Guidelines.

2.4 A *voyage adjustment* deducts relevant fuel consumption, as well as the associated distance travelled from the calculation of attained CII for a defined period subject to certain threshold conditions being met.

2.5 A *correction factor* means a factor in the numerator or denominator of the CII formula which adjusts the calculation of the attained CII.

2.6 A *refrigerated container* is an intermodal shipping container that is refrigerated (including chilled and frozen containers) or heated for the transportation of temperature-sensitive cargo, which will receive its power from the ship's power supply.

2.7 *Ice edge* is defined by paragraph 4.4. of the WMO Sea-Ice Nomenclature, March 2014 as the demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting.

2.8 A tanker should be considered in *Ship-to-Ship (STS)* operation when operating in accordance with regulation 41.2 of MARPOL Annex I and applying the best practices in accordance with the OCIMF Ship to Ship Transfer Guide for Petroleum, Chemical and Liquefied Gases. For the purpose of these guidelines, a tanker is engaged in an STS voyage if a voyage between cargo loading and cargo discharging locations, or a voyage between cargo discharging and cargo loading locations does not exceed 600 nautical miles and the time for each of these voyages (which does not include port or discharge time) is limited to 72 hours.

2.9 A *shuttle tanker* is a tanker which is equipped with dynamic positioning and specialized cargo handling equipment making it capable of loading crude oil at offshore installations.

2.10 A *self-unloading bulk carrier* is a bulk carrier with an onboard cargo handling system that is utilized to discharge dry bulk cargo via a boom conveyor or shipboard cargo pipeline equipment.

3 Application

3.1 For all ships to which regulation 28 of MARPOL Annex VI applies, the operational carbon intensity formula defined in section 4 should be applied when using voyage adjustments or correction factors.

3.2 Rating of ships according to the *2022 Guidelines on the operational carbon intensity rating of ships (CII Rating Guidelines G4)* (resolution MEPC.354(78)) should be carried out using the corrected attained annual operational CII.

3.3 Corrections factors for electrical related fuel consumption $FC_{electrical}$, boiler consumption FC_{boiler} , and other related fuel consumption FC_{others} should not be used for periods where voyage adjustments apply.

4 Attained annual operational CII (CII_{Ship}) formula for voyage adjustments and correction factors

Use of voyage adjustments and correction factors require changes to be made to the overall attained annual operational CII (CII_{Ship}) formula as follows:

$$\frac{\sum_j C_{Fj} \cdot \left\{FC_j - \left(FC_{voyage,j} + TF_j + (0.75 - 0.03y_i) \cdot \left(FC_{electrical,j} + FC_{boiler,j} + FC_{others,j}\right)\right)\right\}}{f_i \cdot f_m \cdot f_c \cdot f_{iVSE} \cdot Capacity \cdot (D_t - D_x)}$$

Where:

- j is the fuel type;
- C_{F_j}represents the fuel mass to CO_2 mass conversion factor for fuel type j, in line with those specified in the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73) as amended by resolutions MEPC.322(74) and MEPC.332(76)), as may be further amended);
- FC_j is the total mass of consumed fuel of type j in the calendar year, as reported under IMO DCS, converted to grams;
- $FC_{voyage,j}$ is the mass (in grams) of fuel of type j, consumed in voyage periods during the calendar year which may be deducted according to paragraph 4.1 of these Guidelines;
- $TF_j = (1 - AF_{Tanker}) \cdot FC_{S,j}$ represents the quantity of fuel *j* removed for STS or shuttle tanker operation, where $FC_{S,j} = FC_j$ for shuttle tankers and $FC_{S,j}$ is the total quantity of fuel *j* used on STS voyages for STS ships. If $TF_j > 0$ then $FC_{electrical,j} = FC_{boiler,j} = FC_{others,j} = 0$;
- AF_{Tanker} represents the correction factor to be applied to shuttle tankers or STS voyages according to paragraph 4.2 of these Guidelines;
- y_i is a consecutive numbering system starting at $y_{2023} = 0$, $y_{2024} = 1$, $y_{2025} = 2$,

etc;

- $FC_{electrical,j}$ is the mass (in grams) of fuel type j, consumed for production of electrical power which is allowed to be deducted according to paragraph 4.3 of these Guidelines;

- $FC_{boiler,j}$ is the mass (in grams) of fuel type j, consumed by the boiler which may be deducted according to paragraph 4.4 of these Guidelines;

- $FC_{others,j}$ is the mass (in grams) of fuel type j, consumed by other related fuel consumption devices according to paragraph 4.5 of these Guidelines;

- f_i is the capacity correction factor for ice-classed ships as specified in the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73) as amended by resolutions MEPC.322(74) and MEPC.332(76), as may be further amended);

- f_m is the factor for ice-classed ships having IA Super and IA as specified in the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73) as amended by resolutions MEPC.322(74) and MEPC.332(76), as may be further amended);

- f_c represents the cubic capacity correction factors for chemical tankers as specified in paragraph 2.2.12 of the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73) as amended by resolutions MEPC.322(74) and MEPC.332(76), as may be further amended);

- $f_{i,VSE}$ represents the correction factor for ship-specific voluntary structural enhancement as specified in paragraph 2.2.11.2 of the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73) as amended by resolutions MEPC.322(74) and MEPC.332(76), as may be further amended), to be applied only to self-unloading bulk carriers*;*

- $Capacity$ is deadweight or gross tonnes as defined for each specific ship type in the *2022 Guidelines on the reference lines for use with operational carbon intensity indicators (CII Reference lines Guidelines, G2)* (resolution MEPC.353(78));

- D_t represents the total distance travelled (in nautical miles), as reported under IMO DCS; and

- D_x represents distance travelled (in nautical miles) for voyage periods which may be deducted from CII calculation according to paragraph 4.1 of these Guidelines.

In case the above voyage exclusion or correction factors are applied, the ship should still report total fuel oil consumption (t) of each type of fuel, total hours under way (h) and total distance travelled (nm) to the Administration pursuant to regulation 27 of MARPOL Annex VI.

All relevant data should be recorded in the ship's logbook. Each parameter, if used, should also be reported to the Administration.

4.1 $FC_{voyage,j}$ for voyage adjustment

The parameter $FC_{voyage,j}$ is the total mass (in grams) of fuel of type j, consumed in voyage periods during the calendar year which may be deducted from the calculation of the attained CII in case the ship encounters one of the following situations:

.1 scenarios specified in regulation 3.1 of MARPOL Annex VI, which may endanger safe navigation of a ship; and

.2 sailing in ice conditions, which means sailing of an ice-classed ship in a sea area within the ice edge.

In cases where $FC_{voyage,j}$ is used:

- any associated distance travelled must also be deducted using D_x otherwise ships will benefit from distance travelled without any associated CO_2 emission.

- the ship should report data for the deductions associated with voyage adjustments to the Administration in accordance with appendix 2 of these guidelines.

4.2 AF_{Tanker} for corrections to shuttle tankers or STS voyages on tankers

Tankers engaged in STS voyages as defined above in paragraph 2.8 may apply the correction factor $AF_{Tanker,STS}$ to all fuel consumption relating to STS voyages, including cargo transfer at offshore location, voyage, cargo discharge and waiting periods at anchor or drifting during which the ship reports being part of an STS operation and voyage. The STS operation includes fuel consumption in port where the transferred cargo is discharged after such a voyage.

The correction is calculated as:

$$AF_{Tanker,STS} = 6.1742 \times DWT^{-0.246}$$

Where $AF_{Tanker,STS}$ is applied, $FC_{electrical}$, FC_{boiler} and FC_{others} should not be used.

Shuttle tankers equipped with dynamic positioning as defined above in paragraph 2.9 may apply the correction factor $AF_{Tanker,Shuttle}$ to total fuel consumption:

The correction factor is calculated as:

$$AF_{Tanker,Shuttle} = 5.6805\ x\ DWT^{-0.208}$$

Where $AF_{Tanker,Shuttle}$ is applied, $FC_{electrical}$, FC_{boiler}, FC_{others} and $AF_{Tanker,STS}$ should not be used.

4.3 $FC_{electrical,j}$ for corrections relating to electrical power

The parameter $FC_{electrical,j}$ is the mass (in grams) of fuel of type j, consumed for production of electrical power during the calendar year which may be deducted from the calculation of the attained CII for the following purposes:

.1 Electrical consumption of refrigerated containers (on all ships where they are carried) using the calculation methodology specified in part A of appendix 1.

.2 Electrical consumption of cargo cooling/reliquefaction systems on gas carriers and LNG Carriers.

.3 Electrical consumption of discharge pumps on tankers.

4.4 $FC_{Boiler,j}$ for corrections relating to boiler fuel consumption

The parameter $FC_{Boiler,j}$ is the mass (in grams) of fuel of type j, consumed by the oil-fired boiler during the calendar year which may be deducted from the calculation of the attained CII, for the purposes of cargo heating and cargo discharge on tankers. The calculation methodology for $FC_{Boiler,j}$ is specified in part B of appendix 1.

4.5 $FC_{others,j}$ for corrections relating to other related fuel consumption devices

The parameter $FC_{others,j}$ is the mass (in grams) of fuel of type j, consumed by standalone engine driven cargo pumps during discharge operations on tankers which may be deducted from the calculation of the attained CII.

4.6 EEDI and EEXI Correction factors

The EEDI correction factors as defined above in paragraph 4 may be applied, provided they are included in the ship's EEDI Technical File or EEXI Technical file.

APPENDIX 1

CORRECTION FACTORS FOR USE IN CII CALCULATION

Part A. $FC_{Electrical}$ for Corrections relating to electrical power

1 Refrigerated containers

For ships carrying refrigerated containers, the correction factor $FC_{Electrical}$ may be applied as follows:

.1 For ships that have the ability to monitor reefer electrical consumption, the ship may calculate reefer container kWh consumption as follows:

$$FC_{electrical\_reefer,j} = Reefer\ kWh \times SFOC$$

where:

- $FC_{electrical\_reefer,j}$ (Reefer fuel oil consumption) represents the estimated fuel consumption attributed to in-use refrigerated containers carried.
- $Reefer\ kWh$ is measured on the ship by the kWh meter counter on the ship.
- $SFOC$ represents the specific fuel consumption in g/kWh as a weighted average of the engines used to provide the electrical power, as per the EEDI/EEXI Technical File or the NO_x Technical File. In the case of ships without a Technical File, a default value of 175 g/kWh for 2 stroke engines and 200 g/kWh for 4 stroke engines may be applied. In the case of waste heat recovery systems as defined under Category C1 in MEPC.1/Circ.896 the SFOC to be used will be at the discretion of the Administration.

Alternatives such as derivation of fuel consumption or kWh from auto-logged data may be used subject to approval by the Administration. Note that ship reefer kWh consumption should not include consumption during voyage adjustment periods.

.2 For ships that do not have the ability to monitor reefer electrical consumption, the ship may calculate reefer kWh consumption as follows:

$$FC_{electrical\_reefer,j} = Cx \cdot 24 \cdot SFOC_{avg} \cdot \left(Reefer\_days_{sea} + \sum Reefer\_days_{port}\right)$$

where:

- Cx represents a default reefer consumption of 2.75 kW/h.
- $Reefer\_days_{sea}$ represents the number of in-use reefer-days over the declared period and may be derived using the number of reefer containers as recorded in the BAPLIE file multiplied by the number of days at sea.
- $SFOC_{avg}$ represents the specific fuel consumption in g/kWh as a weighted average of the engines used to provide the electrical power, as per the EEDI/EEXI Technical File or NO_x Technical File. In the case of ships without a Technical File, a default value of 175 g/kWh for 2 stroke engines and 200 g/kWh for 4 stroke

engines may be applied. In the case of waste heat recovery systems as defined under Category C1 in MEPC.1/Circ.896 the SFOC to be used will be at the discretion of the Administration.

In ports where shore-power is not used, the number of in-use reefers at port should be calculated as:

$$Reefer\_days_{port} = \frac{No_c\ Arrival + No_c\ Departure}{2} \times Days_{port}$$

where:

- $Days_{port}$ represents number of days in port.
- $Reefer\_days_{port}$ represents the number of in-use reefer days while at port.*
- $No_c\ Arrival$ represents number of reefer containers on arrival.
- $No_c\ Departure$ *represents* number of reefer containers at departure.

In all cases, the actual number of in-use reefers carried is documented in the BAPLIE file.

Note that ship reefer kWh consumption should not include consumption during voyage adjustment periods.

* The number of reefers on board while in port should be calculated to equal the number of reefers at arrival and at departure as calculated above. Same calculation applies for Reefer days $_{sea}$ in port.

2 Cargo cooling systems on gas carriers and LNG carriers

For gas carriers and LNG carriers with electrical cargo cooling systems or reliquefaction plants, the correction factor $FC_{electrical}$ may be applied as follows:

.1 Gas carriers and LNG carriers may calculate cargo cooling kWh consumption as follows:

$$FC_{electrical\_cooling,j} = Cooling\ kWh \times SFOC$$

where:

- $FC_{electrical\_cooling,j}$ (cargo cooling fuel oil consumption) represents the estimated fuel consumption attributed to cooling of gas cargoes.
- $Cooling\ kWh$ is measured on the ship by the kWh meter counter on the ship.
- $SFOC$ represents the specific fuel consumption in g/kWh associated with the relevant source of electrical power as per the EEDI/EEXI Technical File or NO_x Technical File. In the case of ships without a Technical File, a default value of 175 g/kWh for 2 stroke engines and 200 g/kWh for 4 stroke engines may be applied. In the case of waste heat recovery systems as defined under Category C1 in MEPC.1/Circ.896 the SFOC to be used will be at the discretion of the Administration.

Alternatives such as derivation of fuel consumption or kWh from auto-logged data may be used subject to approval by the Administration. Note that cargo cooling kWh consumption should not include consumption during voyage adjustment periods.

3 Electric cargo discharge pumps on tankers

For tankers with directly or indirectly electrically powered discharge pumps, the correction factor $FC_{electrical}$ may be applied as follows:

.1 Tankers may calculate cargo discharge kWh consumption as follows:

$$FC_{electrical\_discharge,j} = discharge\ kWh \times SFOC$$

where:

- $FC_{electrical\_discharge,j}$ (cargo discharge fuel oil consumption) represents the estimated fuel consumption attributed to use of cargo discharge pumps.
- $Discharge\ kWh$ is measured on the ship by the kWh meter counter on the ship.
- $SFOC$ represents the specific fuel oil consumption in g/kWh associated with the relevant source of electrical power as per the EEDI/EEXI Technical File or NO_x Technical File. In the case of ships without a Technical File, a default value of 175 g/kWh for 2 stroke engines and 200 g/kWh for 4 stroke engines may be applied. In the case of waste heat recovery systems as defined under Category C1 in MEPC.1/Circ.896 the SFOC to be used will be at the discretion of the Administration.

Alternatives such as derivation of actual fuel consumption from auto-logged data may be used subject to approval by the Administration. Note that cargo cooling kWh consumption should not include consumption during voyage adjustment periods.

Part B. FC_{Boiler} and FC_{Others} for corrections relating to cargo heating and discharge on tankers

1 FC_{Boiler} for cargo heating and discharge pumps on tankers

For tankers with fuel fired boilers used for cargo heating or steam driven cargo pumps, the following correction factor may be applied for the period that the cargo heating or discharge pumps are in operation:

.1 In the case of boilers used for cargo heating, the amount of fuel used by the boiler (FC_{Boiler}) should be measured by accepted means, e.g. tank soundings, flow meters.

.2 For tankers which use steam driven cargo pumps, the amount of fuel used by the boiler (FC_{Boiler}) should be measured by accepted means, e.g. tank soundings, flow meters.

Some amount of fuel consumed by the boiler during cargo heating or discharge operations may be attributed to other purposes, e.g. calorifiers. It is not necessary to split these out from reporting.

Note that boiler consumption should not include consumption during voyage adjustment periods.

2 FC_{Others} for discharge pumps on tankers

For tankers with discharge pumps powered by their own generator, the amount of fuel used for the period that the discharge pumps are in operation (FC_{Others}) should be measured by accepted means, e.g. tank soundings, flow meters.

Note that fuel deducted under FC_{Others} should not include consumption during voyage adjustment periods.

APPENDIX 2

GUIDANCE ON REPORTING OF FUEL OIL CONSUMPTION AND DISTANCE TRAVELLED FOR VOYAGE PERIODS WHERE THE SHIP MEETS THE CRITERIA TO APPLY ANY VOYAGE ADJUSTMENT

In this appendix guidance is given for reporting and verification of fuel oil consumption and distance travelled concerning voyage adjustments when a scenario specified in regulation 3.1 of MARPOL Annex VI applies, which may endanger safe navigation of a ship, or when sailing in ice conditions.

1 Fuel oil consumption for voyage periods should include all the fuel oil consumed on board including but not limited to the fuel oil consumed by the main engines, auxiliary engines, gas turbines, boilers and inert gas generator, for each type of fuel oil consumed, regardless of whether a ship is under way or not. Methods for collecting data on fuel oil consumption in metric tonnes include the method using flow meters or method using bunker fuel oil tank monitoring on board as described in paragraphs 7.1.2 and 7.1.3 of the *2022 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP Guidelines)* (resolution MEPC.346(78)) correspondingly.

2 The distance travelled over ground in nautical miles for voyage periods should be recorded in the logbook in accordance with SOLAS regulation V/28.1 and submitted to the Administration.

3 At the end of the voyage, if the ship has encountered ice conditions during its voyage, when the ship was under way sailing between the ice edges or between the ice edge and the port, or when a scenario specified in regulation 3.1 of MARPOL Annex VI applies:

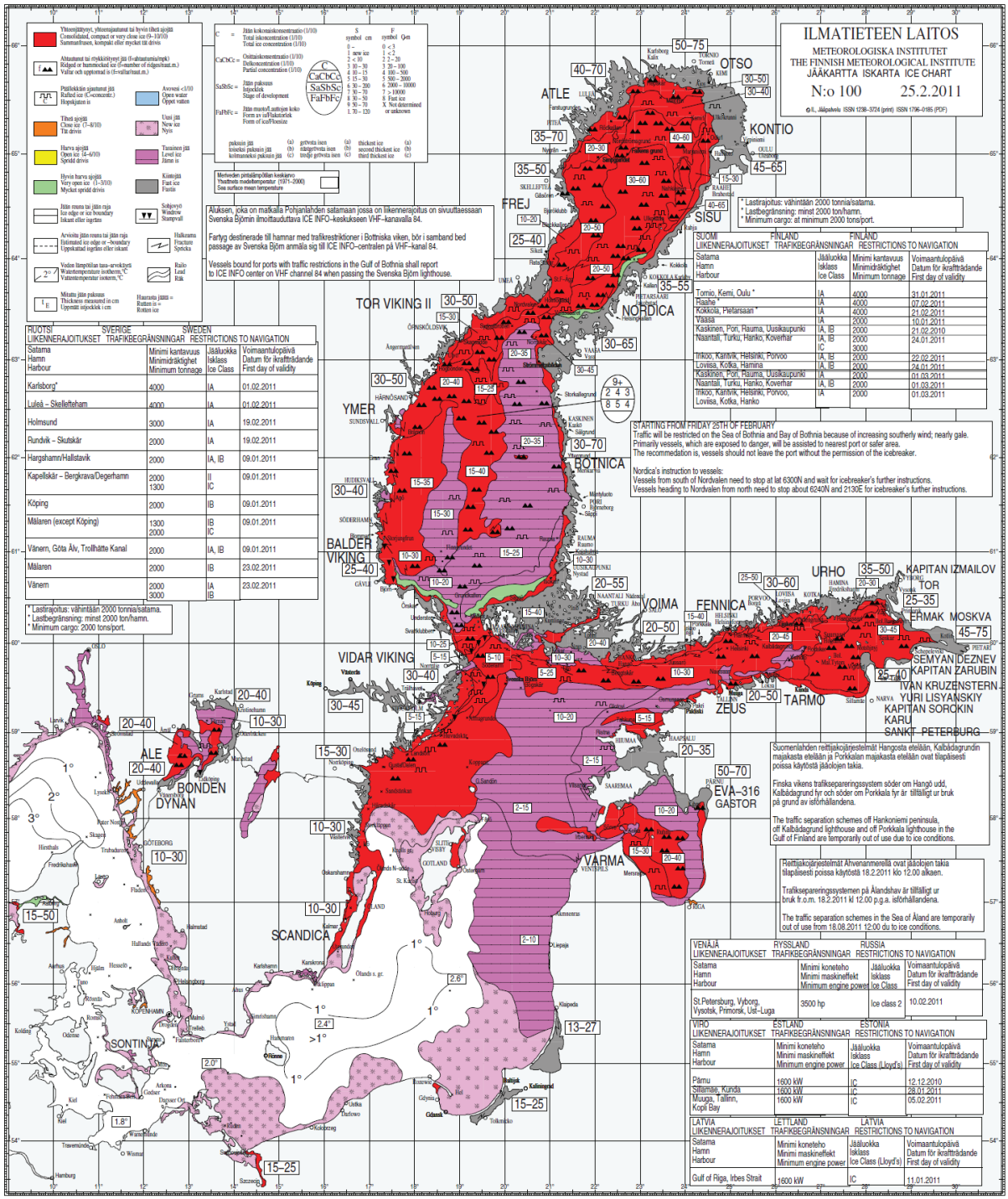
.1 the fuel oil consumed measured in accordance with 7.1.2 or 7.1.3 of the SEEMP Guidelines for the voyage period should not be included in the calculations for the annual average attained CII index value;

.2 if the voyage period is excluded from calculations of the attained CII index value when a scenario specified in regulation 3.1 of MARPOL Annex VI applies, the distance travelled should be clearly marked in the SEEMP monitoring plan, the ship's logbook should include data entries for the voyage period with date, time and position of the ship, when a scenario specified in regulation 3.1 of MARPOL Annex VI started to apply and ceased to apply, and data should be added to the data reporting format;

.3 if the voyage period is excluded from calculations of the attained CII index value due to sailing in ice conditions, the distance travelled should be clearly marked in the SEEMP monitoring plan, the ship's logbook should include data entries for the voyage period with date, time and position of the ship when the ship encountered ice conditions and left ice conditions, and data should be added to the data reporting format.

4 The summary of monitoring data containing records of measured fuel oil consumption and distance travelled for voyage periods should be available on board. Ice charts related to the voyage periods should also be available if the ship has sailed in ice conditions.

Figure 1: An example of an ice chart of the Baltic Sea area



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MEPC.1/Circ.901
24 June 2022

GUIDANCE ON METHODS, PROCEDURES AND VERIFICATION OF IN-SERVICE PERFORMANCE MEASUREMENTS

1 The Marine Environment Protection Committee, at its seventy-eighth session (6 to 10 June 2022), approved the *Guidance on methods, procedures and verification of in-service performance measurements* for the purpose of the EEXI calculation, as set out in the annex.

2 Member Governments are invited to bring the annexed Guidance to the attention of their Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

GUIDANCE ON METHODS, PROCEDURES AND VERIFICATION OF IN-SERVICE PERFORMANCE MEASUREMENTS

CONTENTS

1 Introduction

In cases where 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 obtained from the in-service performance measurement method for the purpose of the EEXI calculation, in accordance with paragraph 2.2.3.5 of the EEXI Calculation Guidelines, as set out in resolution MEPC.350(78).

2 Overview

2.1 When carrying out the in-service performance measurements, common international standards[1] should be referred to, unless explicitly specified in this guidance.

2.2 An overview of preparations and procedures are outlined in the table below. The preparations and the processes should be discussed and agreed at the pre-meeting, see section "Preparations".

Table 1: In-service performance sea trial preparations and procedures

In-service performance measurement analysis	
Step 1: Preparing sensors	• Speed log / GPS • Echosounder • Heading control • Fuel flow meter • Shaft torsion meter • Draft measurement • Gyro compass
Step 2: Pre-trial parameters	• Displacement • Forward/Aft draughts • Water depth • Air/Sea temperature • Seawater density • Anemometer height • Fuel density • Fuel LCV
Step 3: In-service performance measurement	• Sea state • Wind • Water depth • Currents
Step 4: During trial parameters	• Reported data • System prints • Equipment control • Fuel analysis
Step 5: Documentation	• Shaft RPM/Power • Heading • Ship's speed • Distance • Wind speed/direction • Current speed/direction • Wave height/period/direction

[1] Such as ITTC quality procedures, ISO 15016:2002, ISO 15016:2015 and/or ISO 19030:2016.

2.3 When using the in-service performance measurement method, a meeting should be arranged between all stakeholders involved in the process: the owner, the possible consultant, the verifier and the authority before conducting the in-service performance measurements. An overview of the available information including but not limited to ship design, energy saving devices (ESD) and measurement sensors should be included. The plan for the period of the in-service performance measurements should be agreed upon and expectations regarding the delivery of the analysis and its format should be aligned.

3 Preparations

3.1 One of the most important aspects of a successful in-service performance measurement procedure is the preparation. Relevant instruments should be calibrated and their operational conditions prior to the commencement of the trials should be confirmed by the verifier.[2] The list below indicates the primary instruments to be used for collecting the data:

Table 2: Sensors for In-service performance trials

Sensor	Remarks
Shaft torque meter	The measurement system should be certified for power measurements with a bias error as small as practicable. Zero setting checked before and after test.
GPS	The GPS system should operate in the differential mode to ensure sufficient accuracy.
Anemometer	It should be clear of possible obstructions (superstructure, masts, funnel, etc.) and its height from sea level recorded.
Draft measurements	Draft measurement system (if available and calibrated): Otherwise, physical observation is required.
Speed log	The sensor should have been cleaned recently.
Echo sounder	Important for checking water depth for safety and ensuring there are no effects from shallow water on the ship performance.
Course recorder	Should be checked before the trial and be able to provide a course printout following each trial run.
Fuel flow meter	Either volume flow or mass flow meters to be fitted to ships. Both should be calibrated and cleaned/maintained as per manufacturer's recommendations.
Gyro compass	Record the ship's heading during the voyage and should be calibrated prior to the trials.

3.2 The ship should be equipped with a calibrated shaft torque meter, at least for the complete duration of the in-service performance measurement. For verification and cross checks, the detailed fuel properties information, the logged engine room conditions and the fuel oil consumption details will give an estimate of the power used at a certain fuel oil consumption value.

3.3 If an automated data acquisition system is installed on board, this should be checked for accuracy prior to the performance measurements, to ensure that the system has the required precision and measurement frequency, that can provide a trace of all the data required.

[2] The Verifier is the flag Administration, or a competent organization delegated by the flag Administration.

3.4 Before the start of each performance measurement run, the following should be noted in the data logging template form (example appendix C):

Table 3: In-service environment and conditions

Parameter	**Remarks**
Displacement	Speed trials should be performed at displacement and draught conditions, which are comparable to those of the delivery sea trials or model tests or assumed ballast conditions. The trim shall be maintained within very narrow limits. For the even keel condition, the trim shall be less than 0.1 % of the length between perpendiculars. For the trimmed trial condition, the fore draught shall be within ± 0.1 m of the ship's ideal condition.
Draught forward, mid and aft	
Water depth	No remarks
Air temperature	Air temperature and pressure should be measured using a calibrated thermometer and barometer.
Air pressure	
Sea water temperature	The local seawater temperature and density at the trial site should be recorded to enable the calculation of the ship's displacement and corrections with regards to viscosity. The water temperature should be taken at the waterline level.
Sea water density	
Anemometer height	Its height from sea level should be recorded.
Fuel density	The fuel's density and LCV to be obtained from a laboratory's analysis report.
Fuel LCV	

3.5 The in-service performance measurements should be performed at the EEXI draught condition, and if data exists for a reference condition, then a set of in-service performance measurements may also be performed at this condition in order to better calibrate the speed-power relation.

.1 The reference condition is the condition for which the ship documentation exists, e.g. a sea trial curve in ballast or a sea trial/model test curve in design conditions. The in-service performance measurement result may be calibrated towards the reference condition curve. The use of a reference condition, if available, should not lead to overestimation of the Vref but can be a useful tool to verify and calibrate the speed-power relation. If a reference condition is used, this calibration result may also be used for the EEXI draught condition.

.2 The EEXI draught condition is the draught condition as provided by paragraph 2.2.2 of the *2018 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.308(73), as amended, the "EEDI Calculation Guidelines" hereafter). The performance measurements results are used with the same calibration factor as at the reference condition if available.

3.6 In case the exact EEXI draught condition cannot be met, the Admiralty Coefficient formula may be accepted to adjust the speed-power relation, only for displacement variations of up to 2%, or to the satisfaction of the verifier.

3.7 The ship should perform at least one set of in-service performance measurements for the EEXI draught condition, and at power settings equivalent to the EEDI trial conditions (set out in MEPC.1/Circ.855/Rev.2, as amended). If that is not possible, then at each of the following power settings of 30%, 60%, 75% and 90% of MCR, with a margin of +/– 5%. If data for a reference condition is available, another set of in-service performance measurements should also be carried out at this condition for calibration purposes.

3.8 In case where an overridable Shaft/Engine Power Limitation is installed, the power settings of 30%, 60%, 83% and 90% of the limited power may be used, with a margin of +/– 5% for both sets of in-service performance measurements, to the satisfaction of the verifier.

3.9 If the in-service performance measurements are performed at consecutive power settings, sufficient time in between change of settings should be considered, to be sure that steady state conditions are obtained.

3.10 The duration of each run should be performed according to table 4.

3.11 Prior to the in-service performance measurements, the weather forecast should be studied to ensure that favourable weather conditions will prevail during the trials (close to calm conditions).

3.12 Crew members involved in the execution should be familiar with the performance measurements and be aware of their tasks and the importance of the measurements collected.

3.13 Safety of the ship is paramount, and the performance measurements should be suspended should any risks to the ship and/or crew be detected. All rules and regulations, as well as good seamanship, are to be followed at all times.

3.14 The conditions and plans specified in this section should be examined and confirmed by the verifier prior to the in-service performance measurements.

3.15 The ship may experience fouling of the hull and the propeller, which may influence the performance of the ship. If the ship is heavily fouled during the in-service performance measurements, the V_{ref} attained may be less than expected and this will lead to a penalty in the attained EEXI. It is recommended to carry out in-service performance measurements when the ship has a clean hull and propeller.

3.16 The ship may have installed ESDs post delivery. This will affect the performance and the in-service measurement may be used to reflect the effect of ESDs, as provided in paragraph 2.2.3.7 of the EEXI Calculation Guidelines.

4 During the in-service performance measurements

4.1 Once the in-service performance measurements have begun, variations should be minimized, as the accuracy of the ship performance measurements can be influenced greatly by fluctuations in the parameters. Thus, all control levers should remain unchanged.

4.2 An experienced helmsman or adaptive autopilot will be required to maintain heading during each run. Minimum rudder angles are to be used while maintaining a steady heading. The helm corrections should be limited to five (5) degrees or less.

4.3 The following conditions should be met, in order to reduce the influence of corrections and obtain the best possible accuracy of the results of the performance measurements:

Table 4: Environmental conditions for in-service performance measurements

Parameter	Remarks
Sea state	Conditions as specified in ISO 15016: 2015
Wind speed	Conditions as specified in ISO 15016: 2015
Water depth	Conditions as specified in ISO 15016: 2015
Currents	Avoid areas with known high current values and variations. During the trials, the following condition should be met: $V_{GPS} - V_{STW} < 0.3\ knots$, or conditions as specified in ISO 15016: 2015
Trials period	Trials should be conducted in daylight
Duration	The run duration should be the same for all speed runs with a minimum of 10 minutes, see figure 1 below

4.4 If any of above conditions are no longer met during in-service performance measurements, it should be necessary to abandon the run.

4.5 Each set of the in-service performance measurements in the respective load condition should be executed as at least one set of double runs. It is important that the ship is running on the same track and when the monitoring begins, the conditions are in steady state conditions. Each speed run should be commenced and completed at the same place.

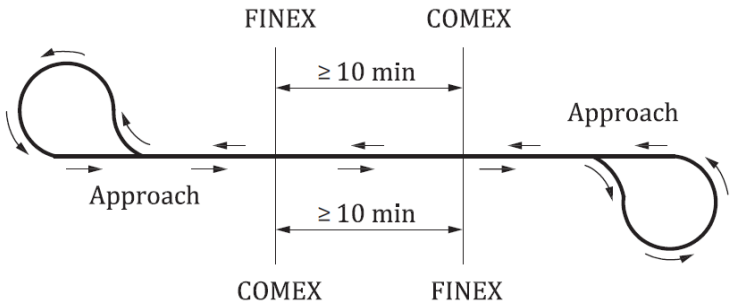


Figure 1: Sea trials with double runs

4.6 During the in-service performance measurements, accurate recordings of the required parameters are of great importance. Recording of parameters for each run should start when steady state ship conditions are met.

4.7 The following data should be collected at the beginning and end of each performance measurement run:

Main engine supply flowmeter reading	[ltr/h] or [kg/h]
Main engine supply flowmeter temperature	[deg]
Main engine return line flowmeter reading*	[ltr/h] or [kg/h]
Main engine return line flowmeter temperature*	[deg]

(*For ships fitted with flowmeter on return line)

4.8 The following data should be collected with a sampling rate of at least 1 Hz during the in-service performance measurement:

Table 5: Logged parameters during in-service performance measurements

Parameter	**Unit**
Date	dd-mm-yyyy
Time	hh:mm:ss
Revolution counter reading	[s^{-1}]
Shaft power	[kW]
Heading	[deg]
Ship's speed (GPS and Speed Log)	[knots]
Distance ("0" should be at the beginning of each run)	[nm]
Relative wind speed	[m/s]
Relative wind direction (coming from)	[deg]
Current speed	[knots]
Relative current direction (going to)	[deg]
Observed wave height	[m]
Observed wave period	[s]
Observed wave direction (going to)	[deg]

4.9 Apart from power, rpm and consumption, average prevailing values for the following main engine parameters should be provided for each run for the following:

Scavenge air temperature	[deg]
Scavenge air pressure	[kg/cm2]
Blower air inlet temperature	[deg]

4.10 These, as well as any other main engine data should be collected at local sensors' display and not their repeaters inside the ECR.

4.11 As far as practicable, the in-service performance measurement should be witnessed by the verifier. The verifier should be able to confirm that the in-service performance measurement was conducted in accordance with the agreed procedures.

5 After the in-service performance measurements

5.1 All information collected should be checked by the verifier and any errors/typos should be noted in supplementary documentation, including any corrected/replaced values clearly marked in the form. Data which is continually recorded should be provided "as is" and non-variable data should be noted at the beginning and the end of the in-service performance measurements in order to confirm that any changes are set to a minimum.

5.2 For each run the following should be submitted:

.1 one filled-in soft copy of the "In-service performance monitoring reporting form" (appendix C);

.2 printouts and/or soft copies from the performance monitoring system output;

.3 printouts and/or soft copies from the loading computer calculations representing the loading condition at which the run took place; and

.4 printouts and/or soft copies from the course recorder for the period covering the run.

5.3 Also, a copy of the fuel oil analysis for the fuel used during the in-service performance measurements should be submitted.

5.4 Any comments about the in-service performance measurements, including any large variations in environmental conditions, should be noted.

5.5 A summary of the required information to be submitted for verification can be found in appendix A, B, and C.

APPENDIX A

INFORMATION TO BE SUBMITTED PRIOR TO CONDUCTING THE IN-SERVICE PERFORMANCE MEASUREMENTS

The following information should be submitted prior to conducting the performance measurements.

Document	**Mandatory**	**Optional**
Hydrostatics	☐	☒
Shop tests of main engine	☒	☐
Sea trials (machinery and hull part)	☒	☐
Model tests	☐	☒
Propeller characteristics and structural drawings	☐	☒
GA drawing	☒	☐
Details of appendages and rudder	☐	☒
Fuel oil piping diagram	☐	☒

Ship's main particulars

IMO number:	
Date delivered:	
Ship's email address(s):	
Date ship was launched (when did ship enter the water):	
Ship's name:	
Owner:	
Managing company:	
Ship type:	
Ship capacity	
Yard:	
Length overall (m):	
Length between perpendiculars (m):	
Breadth moulded (m):	
Depth to upper deck (m):	
Design draft (m):	
Design displacement (mt):	
EEXI draft (m):	
Displacement at EEXI draft (mt)	
Lightship weight (mt)	

Design speed (knots):	

Dry-docking history (within the last five years):			
Date	Yard	Coating specs	Hull treatment
		Please attach	Please attach

Hull cleaning and propeller polishing history since last dry-dock:			
Date	Place	Brief description of works	Propeller polishing standard*

*only for propeller polishing events

Main engine(s)	
Maker:	
Type:	
Number:	
Type of fuel:	
MCR (kW):	
SMCR (kW) x RPM:	

Main engine modifications/upgrades		
	Yes	No
Derating	☐	☐
T/C cut offs	☐	☐
Part load tuning	☐	☐
Low load tuning	☐	☐
Retrofit	☐	☐
(please provide details)		
Other modifications	☐	☐
(please provide details)		

Propeller(s) including modifications/upgrades	
Type: (FP or CPP)	
Diameter (m)	
Pitch (m)	
Number	

	Yes	No
Trimmed	☐	☐
Other (please state)	☐	☐

Propulsion improvement devices		
	Yes	No
Ducts	☐	☐
Fins	☐	☐
Other (please provide details)	☐	☐

Power measurements		
	Yes	No
By torsion meter	☐	☐
(Details of torsion meter including last calibration)		
By load indicator diagrams	☐	☐
Other method (please provide details)		

Performance monitoring systems		
	Yes	No
PMS	☐	☐
please provide details of type and maker		

Fuel measurements		
	Yes	No
By volume flowmeter	☐	☐
(Details of flowmeter including last calibration)		
By mass flowmeter	☐	☐
(Details of flowmeter including last calibration)		
Soundings	☐	☐

Other instruments & gauges used for data collection	
	Dates of Calibration
Speed log	
DGPS	
Anemometer Provide height of anemometer in metres:	
Other (please provide details)	

Additional information		
	Yes	No
Reduction gear	☐	☐
(please provide details)		
Shaft motor	☐	☐
(please provide details)		
Shaft generator	☐	☐
(please provide details)		

Person to be contacted for further info:	

APPENDIX B

INFORMATION TO BE SUBMITTED FOR VERIFICATION AFTER THE IN-SERVICE PERFORMANCE MEASUREMENTS

The following information needs to be submitted after conducting the in-service performance measurements.

Document	Mandatory	Optional
Calibration certificate of torquemeter	☒	☐
Calibration certificate of flowmeters	☐	☒
Calibration certificate of anemometer	☐	☒
Calibration certificate of speed log	☐	☒
Calibration certificate of GPS	☐	☒
Calibration certificate of echosounder	☐	☒
Calibration certificate of gyro compass	☐	☒
Fuel oil analysis	☒	☐

Furthermore, for each run, the following needs to be submitted:

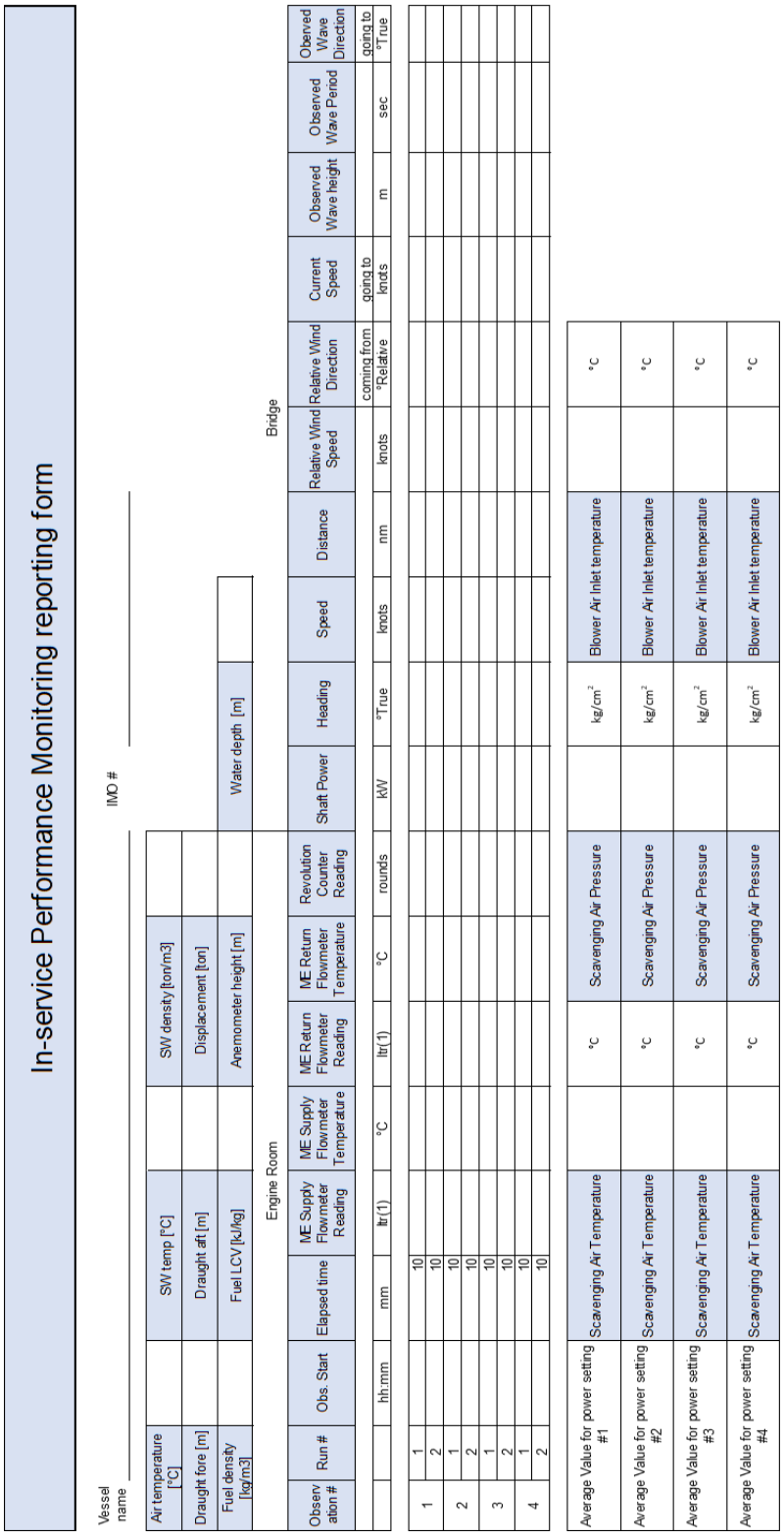
Document	Mandatory	Optional
Sea trial reporting form	☒	☐
A printout of course recorder	☒	☐
A printout of ME load indicator (depicting the loading condition of the ship during the trials)	☐	☒ *
A printout/soft copy of the anemometer output (if the anemometer is digital)	☐	☒ *

* Optional, but highly recommended outputs

APPENDIX C

EXAMPLE OF THE IN-SERVICE PERFORMANCE MEASUREMENTS REPORTING FORM

The form below includes all in service measurements at one loading condition.



In-service Performance Monitoring reporting form

Vessel name _____ IMO # _____

Air temperature [°C]		SW temp [°C]		SW density [ton/m3]			
Draught fore [m]		Draught aft [m]		Displacement [ton]			
Fuel density [kg/m3]		Fuel LCV [kJ/kg]		Anemometer height [m]		Water depth [m]	

				Engine Room								Bridge								
Observation #	Run #	Obs. Start	Elapsed time	ME Supply Flowmeter Reading	ME Supply Flowmeter Temperature	ME Return Flowmeter Reading	ME Return Flowmeter Temperature	Revolution Counter Reading	Shaft Power	Heading	Speed	Distance	Relative Wind Speed	Relative Wind Direction	Current Speed	Observed Wave height	Observed Wave Period	Obenved Wave Direction
		hh:mm	mm	ltr(1)	°C	ltr(1)	°C	rounds	kW	°True	knots	nm	knots	coming from °Relative	going to knots	m	sec	going to °True
1	1		10															
	2		10															
2	1		10															
	2		10															
3	1		10															
	2		10															
4	1		10															
	2		10															

Average Value for power setting #1	Scavenging Air Temperature	°C	Scavenging Air Pressure	kg/cm²	Blower Air Inlet temperature	°C
Average Value for power setting #2	Scavenging Air Temperature	°C	Scavenging Air Pressure	kg/cm²	Blower Air Inlet temperature	°C
Average Value for power setting #3	Scavenging Air Temperature	°C	Scavenging Air Pressure	kg/cm²	Blower Air Inlet temperature	°C
Average Value for power setting #4	Scavenging Air Temperature	°C	Scavenging Air Pressure	kg/cm²	Blower Air Inlet temperature	°C

No. 172 EEXI Implementation Guidelines

(June 2022)

Introduction

These guidelines have been developed by IACS in response to the Resolutions MEPC.333 (76), MEPC.334 (76), and MEPC.335 (76) relating to EEXI. The document may be updated whenever new issues are brought to the attention of IACS.

1 Capacity

- For ships where the capacity refers to deadweight, the deadweight of the ship should be taken as the one in the approved stability information or loading manual.

- For ships where the capacity refers to gross tonnage, the gross tonnage is to be taken from the International Tonnage Certificate.

1.1 Multiple Loadlines

- EEXI calculation using the deadweight at maximum (summer) draught as per IEEC Supplement.

- Flag Administration to advise whether the remaining Load Lines certificates on board are required to be assessed.

2 Ship Type

The ship type should match the ship type mentioned in the IEE Certificate, except for LNG Carriers that were categorised as Gas Carriers under Phase 1 of EEDI. Some ship sizes may have only an *Attained EEXI* without a *Required EEXI*. 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 excluded from Attained and *Required EEXI*.

3 EEXI Technical File

3.1 EEDI Technical File vs EEXI Technical File

The EEDI Technical File (EEDI TF) can be submitted for EEXI verification in case the *Attained EEDI*, as documented in the IEE Certificate regardless of the guideline applied at the time of construction, complies with *Required EEXI*. If verification is based on EEDI TF, the supporting documentation should include:

- Cover letter explaining that the ship has not undergone major changes which would affect the final achieved EEDI

- EEDI TF

- IEEC Supplement and/or Review/Approval Letter

No. 172 (cont)

3.2 Dealing with mistakes in EEDI Technical File

In case a mistake is found in a submitted EEDI TF, which was reviewed/approved at ship's delivery, then for cases where a power limitation is implemented to satisfy the *Required EEXI*, the *Attained EEXI* will be calculated based on the correction and an EEXI Technical File to be reviewed/approved.

3.3 Pre-EEDI SOVC Consideration

Irrespective of whether a pre-EEDI ship has a Statement of Voluntary Compliance (SOVC) or a Preliminary Approved EEDI TF, then the ship will still need to prepare an EEXI Technical File and the *Attained EEXI* will be reflected in the IEEC Supplement.

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

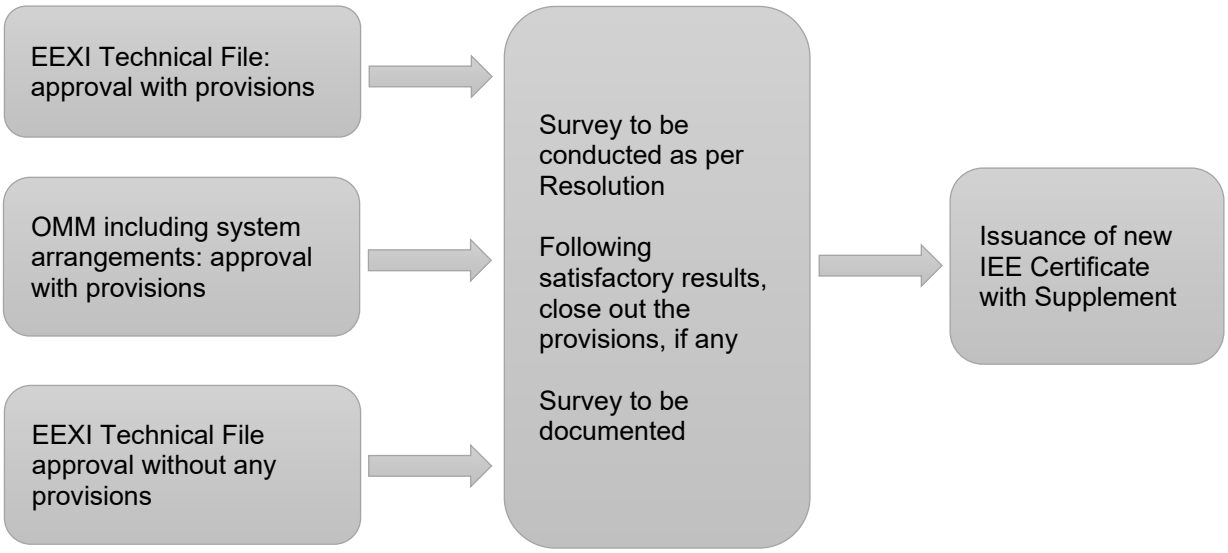
In case of EPL/SHaPoLi is intended to be implemented to satisfy the *Required EEXI*, the EEXI Technical File can be approved provided the following supporting documentation is included:

- SFC at new PME to be included. See Section 5 on SFC considerations.

- For ships subject to the NOx Technical Code: In case of change of engine critical settings or components, affecting NOx Technical File, then NOx Technical File to be amended. A statement from engine maker may be considered as acceptable supporting documentation and filed together with NOx Technical File.

3.5 EEXI Technical File & OMM Approval Process

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



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

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

No. 172 (cont)

4 Ship speed V_{ref}

4.1 Transfer from Service/Design draft to EEXI draft

There are three different options to transfer a known speed/power curve from a specific draft to the EEXI draft:

1. Model tests/ CFD calculation: Curves are determined for both drafts, 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 drafts.

3. The formula in MEPC.333(76) para 2.2.3.4: A factor is calculated from the relation of the deadweight of both drafts.

Only model test or CFD calculation can be applied for the transfer from trimmed ballast draft to the EEXI draft. Admiralty equation and the formula in MEPC.333(76) para 2.2.3.4 can only be used for the transfer from design or service draft on even keel to EEXI draft.

Although MEPC.333(76) para 2.2.3.4 refers to the service power point only, the speed/power curve in design load draft should be considered for the transfer to the EEXI draft following the formula in MEPC.333(76) para 2.2.3.4.

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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 as given in the next paragraphs.

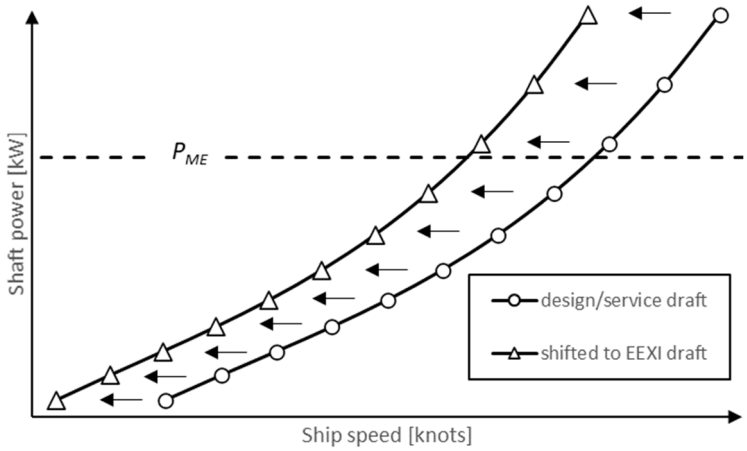


Figure 4.1 Shift of design/service draft model test curve to EEXI draft

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

No. 172 (cont)

4.1.1 Ships other than bulk carriers, tankers and containerships

The Admiralty equation is a well-known formula for estimation of required power *P* depending on displacement Δ 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.

Case A

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

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

Case B

The 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:

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

Applicability criteria

Case	The following criteria to be assessed at the P_{ME} in the original unlimited power case.
For case A	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.
For case B	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.

No. 172 (cont)

4.1.2 Bulk carriers and tankers

Admiralty equation not to be applied for bulk carriers and tankers. For bulk carriers and tankers, the formula in MEPC.333(76) para 2.2.3.4 with scale coefficient *k* as defined in MEPC.333(76) can be applied to transfer the speed-power curve from a draft that is below the maximum summer load draft. The term *DWT* for *k* factor definition refers to the DWT at the summer load draft (and not the $DWT_{s,service}$).

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

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

In MEPC.333(76) there is no limit for the DWT relation given when applying the formula in MEPC.333(76) para 2.2.3.4. The service draft to be on even keel, a trimmed draft cannot be applied for the formula in MEPC.333(76) para 2.2.3.4.

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

4.1.3 Containerships

Admiralty equation not to be applied for containerships. For containerships, the formula in MEPC.333(76) para 2.2.3.4 with scale coefficient *k* as defined in MEPC.333(76) can be applied to transfer the speed-power curve from a draft that is different from the EEXI draft. For containerships this different draft might be larger or smaller than the EEXI draft which is defined by *70% DWT*.

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

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

The V_{ref} at EEXI draft is calculated based on the containership size as per table below.

In the table below the term *DWT* refers to the DWT at the summer load draft (and not the $DWT_{s,service}$) and the term *Capacity* refers to MEPC.308(73) chapter 2.2.3.

No. 172 (cont)

Ship size applicability	Derivation of Vref
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 draft is available, the speed V_d is derived at the P_{ME}. Subsequently, the V_{ref} at EEXI draft 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 draft is not available and only one service point is available ($P_{s,service}$, $V_{s,service}$), then the V_{ref} at EEXI draft 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 < (DWTs,service / Capacity)* **≤** *1.12*	*Vref* to be derived from the available curve at P_{ME}.
Where: *DWT* **≤** *120000 tonnes* and *1.0 < (DWTs,service / Capacity)* **≤** *1.08*	*Vref* to be derived from the available curve at P_{ME}.

4.2 Change of EEXI draft

In case of change of EEXI draft:

- The new speed may be derived following the application of Admiralty equations as described earlier, or
- $V_{ref,app}$, or
- V_{ref} as per the formula in MEPC.333(76) para 2.2.3.4, extrapolating from design draft to new EEXI draft or from the old EEXI draft to new EEXI draft.

The maximum summer load draft deadweight is to be used, according to paragraph 2.2.4 of MEPC.308(73). In absence of the speed power curve at summer load draft, reference can be made to the so-called “scantling draft” speed power curve, which is to be adjusted as per above.

In case the final Vref 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) $e.g. P = a * V^b$.

No. 172 (cont)

4.3 Service Speed & Power Definition

As per discussions at the Correspondence Group before the MEPC76, based on submissions ISWG-GHG 7/2/31, the service speed and service power are defined as follows:

- Service Power = $\frac{NCR}{1+SM}$ or $\frac{CSR}{1+SM}$

- with *NCR* = *CSR*, as shown in the sea trial and/or model test report and/or ship's technical specification

- and *SM* stands for Sea Margin as per the sea trial and/or model test and/or ship's technical specification

- Service speed is the speed corresponding to the service power.

4.4 Sister ship V_{ref}

A sister ship is one built in a series by same shipyard with identical main dimensions, body lines, appendages, and propulsion system.

For pre-EEDI ships it was common practice to perform detailed sea trials for the lead ship of a series whilst for the rest of sister ships a reduced scope was applied, i.e. one double run. In such case, results from model tests or numerical calculation can be considered for the whole series. Whilst for the lead ship the model test curve can be calibrated by the sea trial results if adequately documented, for the sister ship the calibration of the model test curve to the sea trial result should not be carried out in case only a single double run was performed as in such case the tidal current was ignored.

In a case of identical Propulsion Improvement Device 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 sisters with means of deriving a new speed-power curve.

4.5 Pre-EEDI ship with Sea Trial Report

MEPC.334(76) states that sea trial results are acceptable when in accordance with "ISO 15016:2002 or equivalent". Equivalence is difficult to define, especially in regard of the fact that the 2015 version of the guideline follows a different approach than the 2002 version. For example, the BSRA method is similar with ISO 15016:2015 but different from ISO 15016:2002. The minimum requirement to 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, can be considered as valid supporting documentation for the EEXI calculation, even if the speed-power curve is uncorrected at a weather condition. 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.

4.6 Pre-EEDI ship with Sea Trial Report and Model Tests Report

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.

No. 172 (cont)

4.7 Performance of new Sea Trial based on ISO 15016:2015

For both pre-EEDI and EEDI certified ships, in case of new sea trial, the analysis is to be based on ISO 15016:2015:

- Prior the sea trials, the sea trial plan to be submitted to Class for confirmation that it is according to ISO 15016:2015. Power settings may be selected with the view to potential power limitation.

- Sea trials to be witnessed by Class Surveyor and a witnessing statement to be issued.

- Sea trial analysis can be carried out only if relevant data at EEXI draft and sea trial draft are available from model tests and/or numerical calculations.

- The sea trial analysis software program utilized must be acceptable to Class.

- The EEXI Technical File will include the sea trial analysis and the Surveyor's statement are to be submitted as supporting documentation along with the EEXI Technical file.

4.8 PID retrofit with comparative model tests

In case of retrofitted propulsion improvement device (PID) where comparative model tests have been carried out, the V_{ref} derived from the following recommended processes 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's consideration. For instance, when the original speed-power curve is available, then that can be applied instead of a cubic curve approach.

Case No	Available information	Recommended process 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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 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

No. 172 (cont)

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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 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 MEPC.333(76) para 2.2.3.4 including the *k* scale factor approach is not applicable, the formula per para 4.1.1 should be applied

No. 172 (cont)

4.9 Propeller trimmed cases

Not all propeller trimmed cases are the same. Some cases are cropping off blades for balancing purposes (*usually after a damage of one or more blades*), whilst other cases may be pitch reduction to ease off the ship from a heavy operating range, i.e. to bring operation from the left of the propeller curve onto or to the right of the propeller curve. From an EEXI perspective:

- 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 trials are no longer valid for EEXI calculation. This infers that as in the case of "new propeller" the Owner will need to consider submitting supporting documentation, which may 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.

4.10 Lower Friction Hull Coatings

In case of lower friction hull coatings, which are considered an EET (Energy Efficiency Technology) in Category A as per IMO MEPC.1/Circ 896, the V_{ref} can only derived by sea trials.

No. 172 (cont)

5 SFC considerations

In case of new type of fuel nozzles or optimization of injection:

- the new SFC specified by the main engine designer is acceptable, provided the approved NOx Technical File of the engine is amended accordingly.

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.

The EEXI calculation should be based on the *SFC* value based on the following options:

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 with power limitation	Acceptable	Acceptable	Acceptable	Acceptable
Pre-EEDI without power limitation	To be used	Acceptable only in case of 1 is not available	Acceptable only in case of 1 is not available	Acceptable only in case of 1 is not available
EEDI with power limitation	Acceptable	Acceptable	Acceptable	Acceptable
EEDI without power limitation	Value used in EEDI TF to be used			

Notes:

- If fuel flow (e.g. gr/h) is only available (instead of *SFC*) this can be converted to *SFC*. This is equivalent to measured *SFC*.

- If two or more sets of measurements at the same rating are submitted for the various loads of the same engine, then the average to be used.

- If shop test results and/or NOx Technical file for ME or AE of individual ship and parent engine are not available, those of a sister ship can be used.

- Scrubber retrofits are not considered to affect EEXI calculation in terms of *SFC*.

No. 172 (cont)

6 Power Limitation

In MEPC.335(76) IMO defines measures to limit the propulsion power to be considered in the EEXI calculation. It is distinguished between two different power limitation methods: EPL and SHaPoLi. EPL limits the engine power by restricting the fuel rack (mechanically controlled engines) or the fuel index (electronically controlled engines). Besides, EPL might directly limit the power in electronically controlled engines. SHaPoLi measures the shaft power with an independent torque meter and the limitation is based on this value. The power limitation as described in MEPC.335(76) is defined as overridable.

IACS agrees to consider all power limitation measures that are equivalent to power limitation as described in MEPC.335(76) regarding limitation method, meaning that P_{ME} is 83% of MCR_{lim}.

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.

A different method of power limitation is the derating, e.g. deactivating of cylinders or reduction of stroke length. This limitation is considered in the EEXI calculation following MEPC.308(73) by replacing *MCR* with MCR_{lim}, meaning that P_{ME} is 75% of MCR_{lim}. In the same way a turbocharger cut-out is considered. If the turbocharger is dismantled or blocked with a bolted or welded plate, the limited power is used for determination of *Attained EEXI*. However, if the turbocharger is locked with a butterfly valve, even if sealed, then the P_{ME} is 83% of MCR_{lim}.

When there is no modification on engine side, but the propulsion system is limited to a certain power, e.g. by propeller retrofit, P_{ME} is calculated according MEPC.308(73) chapter 2.2.5.2, option 2, meaning that P_{ME} is 75% of the power the propulsion system is limited to. Whilst this option was limited to propulsion arrangements with a PTO in the EEDI regime, IACS agrees that the option is applicable to all propulsion arrangements regarding EEXI.

The term “propeller retrofit” infers the case where shaft power limitation has or will be applied to avoid damage. The new maximum power after the propeller retrofit is documented in the propeller description or certificate. If for EEXI purposes, the power needs to be reduced below the new maximum power, then the case will be considered as overridable.

Overridable	**Non-overridable (permanent during ship operation)**
EPL or SHaPoLi (see Note 1)	Propeller retrofit with shaft power limitation to prevent damage on the propeller or shaft (see Note 2)
Turbocharger cut-out by butterfly valve (see Note 1)	Turbocharger dismantling (see Note 2)
	Turbocharger cut-out by removable blinding plate, e.g. bolted, or permanent blinding plate, e.g. welded (see Notes 2 and 3)
	Permanent adjustment of fuel index (see Notes 2 and 3)
	Permanent Engine derating, i.e. cylinder cut-off, reduction of combustion volume (see Note 2)

No. 172 (cont)

Notes:

1. The 83% approach is applicable to overridable power limitation cases. Password protected systems are to be considered as overridable.

2. The 75% approach is applicable.

3. 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.

Depending on the power limitation method, different *MCR* values are to be considered in the EEXI formula according to the following table:

Parameter	**Source**		**Variable**	**Overridable** [1]	**Non-overridable other than propeller retrofit** [2]	**Non-overridable propeller retrofit** [3]
	Reference	**Chapter**		**function of**	**function of**	**function of**
P_{ME}	MEPC.333(76)	2.2.1	MCR_{lim}	$83\%\ MCR_{lim}$		
	MEPC.308(73)	2.2.5.1			$75\%\ MCR_{lim}$	
	MEPC.308(73)	2.2.5.2				$75\%\ MCR_{lim}$
P_{AE}	MEPC.308(73)	2.2.5.6	*MCR*	*MCR*	MCR_{lim}	*MCR*
$f_{j,ICE}$	MEPC.308(73)	2.2.8.1	*MCR*	*MCR*	MCR_{lim}	*MCR*
$f_{j,RoRo}$	MEPC.333(76)	2.2.6	$V_{ref,F}$	*75% MCR*		
	MEPC.308(73)	2.2.8.3	V_{ref}		P_{ME}= $f(MCR_{lim})$	P_{ME}= $f(MCR_{lim})$
$f_{j,GeneralCargo}$	MEPC.308(73)	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 MEPC.333(76)

2. calculation following MEPC.308(73) by replacing *MCR* with MCR_{lim}

3. calculation following MEPC.308(73) chapter 2.2.5.2 option 2

6.1 PTO

For cases with shaft generator PTO and overridable power limitation, the formula for P_{ME} is as follows, unless it is decided otherwise at IMO.

$$P_{ME} = 0.75 * (MCR_{lim} - P_{PTO}) \text{ with } P_{PTO} \leq \frac{P_{AE}}{0.75}$$

No. 172 (cont)

6.2 Cruise ships with diesel electric propulsion

For cruise ships with diesel electric propulsion, the propulsion power of the electric engines MPP is the relevant power for the EEXI calculation. A limitation of this electric power by technical means (e.g. restriction of current) is an EPL with relevant power MPP_{lim}. Alternatively, the propulsion power can be limited by measuring the shaft power with a SHaPoLi system.

The rated output of the electric propulsion motors *MPP* can be identified with the quantity noted $P_{PTI,Shaft}$ in MEPC.308(73) for the calculation of the EEXI value:

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

In case of power limitation, P_{PTI} is calculated as follows:

$$\sum P_{PTI(i)} = \frac{\sum(0.75 \cdot MPP_{lim}(i))}{\eta_{PTI} \cdot \eta_{Gen}}$$

V_{ref} is obtained at 75% of *MPP* or 75% of MPP_{lim}, respectively.

The diesel engines of the cruise ship are considered as auxiliary engines. The *SFC* is taken at 75% of *MCR* power of the diesel engines as the P_{AE} value is significantly different from total power used at normal seagoing (MEPC.308(73), chapter 2.2.7.1). The *SFC* is independent from potential limitation of the electric engines.

6.3 LNG carriers with diesel electric propulsion

For LNG carriers with diesel electric propulsion, the propulsion power of the electric engines $MPP_{Motor(i)}$ is the relevant power for the EEXI calculation. A limitation of this electric power by technical means (e.g. restriction of current) is an EPL with relevant power MPP_{lim}. Alternatively, the propulsion power can be limited by measuring the shaft power with a SHaPoLi system.

P_{ME} is calculated as follows:

$$P_{ME(i)} = 0.83 \cdot \frac{MPP_{Motor(i)}}{\eta_{(i)}}$$

And in case of power limitation:

$$P_{ME(i)} = 0.83 \cdot \frac{MPP_{lim}}{\eta_{(i)}}$$

V_{ref} is obtained at 83% of *MPP* or 83% of MPP_{lim}, respectively.

The diesel engines of the LNG carrier are called main engines. The SFC_{ME} is taken at 75% of *MCR* power of the diesel engines. The SFC_{ME} is independent from potential limitation of the electric engines.

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The same diesel engines of the LNG carrier are considered as auxiliary engines at the same time. The SFC_{AE} is taken at 75% of *MCR* power of the diesel engines.

In case of overridable power limitation, P_{AE} is to be kept constant as in the original unlimited power case.

6.4 Minimum Propulsion Power

For overridable cases:

- For pre-EEDI bulk carriers, tankers, and combination carriers of 20,000 tonnes deadweight and above, there is no requirement for Minimum Propulsion Power Assessment as per Circular 850, unless the ship has undergone a major modification which is so extensive that the ship is regarded by the Administration as a newly constructed ship. In the latter case, the Minimum Propulsion Power Assessment to be verified according to Circ 850 latest revision at the time of modification.

- For EEDI bulk carriers, tankers, and combination carriers of 20,000 tonnes deadweight and above, there is no need to reassess the Minimum Propulsion Power Assessment as per Circ 850.

For non-overridable (permanent during ship operation) cases:

- For both EEDI and pre-EEDI bulk carriers, tankers, and combination carriers of 20,000 tonnes deadweight and above, the Minimum Propulsion Power Assessment is to be verified according to Circ 850 latest revision at the time of modification.

6.5 Maneuvering

For overridable cases:

- The existing maneuvering booklet, if available, and the maneuvering information displayed on the navigating bridge to include that the ship’s power has been limited and state the limiting power for the attention of the Master to account for the ship’s performance so caused in case no corresponding trials are carried out.

For non-overridable (permanent during ship operation) cases:

- The stopping times and distances, and the data of the turning circles as per SOLAS Reg. II-1/28.3 and Res.MSC.137(76) respectively, to be recorded on new trials where applicable. Also, the existing maneuvering booklet, if available, and the maneuvering information displayed on the navigating bridge (pilot card and wheelhouse poster) to be updated.

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6.6 Onboard Management Manual (OMM)

- Regarding Resolution MEPC.335(76), section 2.1.1.3 *"a control unit for calculation and limitation of the power transmitted by the shaft to the propeller(s)"* : If this control is independent from the engine automation the following shall be satisfied:

  - Override of limitation is indicated by giving an alarm on the bridge, clearly informing the ship's master or 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 as defined in section 2.1.1.2.

  The OMM should clearly define this confirmation of the alarm as the deliberate action in agreement with requirement in chapter 2.2.1.

- Regarding Resolution MEPC.335(76), section 2.1.3 "*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 strictly speaking 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.

- A SHaPoLi / EPL system (or each sub system) in the context of section 2.2 of MEPC.335(76), 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.

- Regarding Resolution MEPC.335(76), section 2.2.5.2 "*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.

- Regarding Resolution MEPC.335(76), section 3.5 "*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.

- The surveyor may issue the IEEC after the EPL/OMM survey where the Surveyor verifies that the arrangements indicated in the OMM are in place.

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6.7 NOx

	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	No	Yes
Permanent adjustment of fuel index	No	No	No	No	Yes (Level 2 assessment is required)
Permanent Engine derating, i.e. cylinder cut-off, reduction of combustion volume	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. A statement from engine maker may be considered as acceptable supporting documentation and filed together with NTF.

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. In general, other class requirements remain as applicable.

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6.8 Barred Speed Range

The following shall apply to the satisfaction of ship's classification society.

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, e.g., cylinder cut-off, reduction of combustion volume	

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7 LNG Carriers

7.1 Treatment of LNG Carriers

EEXI requirement is applied based on the definitions in Regulation 2 of MARPOL Annex VI as they will stand when EEXI enters into force, i.e. separate definitions and ship categories for gas carriers (regulation 2.26) and LNG carriers (regulation 2.38).

For the purposes of compliance with EEXI, an LNG carrier will be an LNG carrier regardless of when ship has been delivered and the ship type applied when her *Attained EEDI* was verified.

It is recognized that there may be confusion in case ship was delivered before 1 September 2019 with an IEEC stating Gas Carrier as ship type. For all other cases the ship is anyway considered as LNG Carrier.

Therefore, to clarify the case when an LNG Carrier delivered before 1 September 2019 with an IEEC stating Gas Carrier as ship type, the requirements are shown in the table below as applicable.

<table>
<tr><td colspan="3">IEEC Gas Carrier delivered before 1 Sept 2019</td></tr>
<tr><td>If there is EEDI TF and the Attained EEDI (as Gas Carrier in the original EEDI TF) is below the Required EEXI as LNG Carrier, then this is acceptable.</td><td>If there is EEDI TF and the Attained EEDI (as Gas Carrier in the original EEDI TF) is above the Required EEXI as LNG Carrier, then Attained and Required EEXI to be calculated as per LNG Carrier.</td><td>If there is no EEDI TF, then the Attained and Required EEXI to be calculated as per LNG Carrier.</td></tr>
<tr><td colspan="3">When the new IEEC is issued during 1st survey in 2023, the IEEC ship type will be changed to LNG Carrier</td></tr>
</table>

7.2 Calculation of Attained EEXI for steam-turbine LNG Carriers

According to MEPC.333 (76) par. 2.2.1, the power from combustion of excessive natural boil-off gas in the engines or boilers to avoid releasing to the atmosphere or unnecessary thermal oxidation, should be deducted from $P_{ME(i)}$ with the approval of the verifier.

The formula for the *Attained EEXI* for steam turbine LNG carriers becomes straightforward as according to MEPC.308(73) no separate term for the auxiliary power is needed:

$$Attained\ EEXI = \frac{P_{ME} \cdot SGC \cdot C_{F,LNG}}{DWT \cdot V_{ref}}$$

In case of power limitation and after deduction of the power from combustion of excessive natural boil-off gas, the formula changes as follows:

$$Attained\ EEXI = \frac{P_{ME\_revised} \cdot SGC(P_{ME\_lim}) \cdot C_{F,LNG}}{DWT \cdot V_{ref}(P_{ME\_lim})}$$

The methodology cannot be applied prior to power limitation.

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Nomenclature

MCR	Maximum Continuous Rating (Value of MCR specified on the Steam Heat Balance and Flow Diagram as Maximum Propulsion Power)
P_{ME}	0.83 MCR
Vref	Reference Speed
SFC	Certified specific fuel consumption, given in g/kWh, of the steam turbines, usually related to HFO with lower caloric value of 40,200 kJ/kg
SGC	Specific gas consumption, the result of SFC's correction 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)
C_F	Conversion factor between fuel consumption and CO2 emission, for LNG, C_F=2.750 t-CO2/t-Fuel
MCR_{lim}	The new MCR to which the propulsion system must be limited to comply with the *Required EEXI*
P_{ME_lim}	$0.83\ MCR_{lim}$
R_f	Reduction factor *Rf (Rf < 1)* with $MCR_{lim} = R_f \cdot MCR$
P_{BOG}	Is the nominal power generated by consuming all boil-off gas from the cargo tanks
$P_{Excessive}$	The excessive power from combustion of excessive natural boil-off gas is defined as the difference between nominal power generated by consuming all boil-off gas from the cargo tanks and MCR_{lim}, $P_{Excessive} = P_{BOG} - MCR_{lim}$
$P_{ME\_revised}$	The relevant power value after deduction of $P_{Excessive}$. This value will be used in the calculation of the *Attained EEXI*, $P_{ME\_revised} = 0.83\ MCR_{lim} - P_{Excessive}$
BOR_{LNG}	Daily boil-off rate, in t/day, $BOR_{LNG} = 0.000864 \cdot V_{Cargo}$
V_{Cargo}	Cargo Tank Volume to be taken as the 100% net volume, as per capacity plan, in m^3

Based on the daily boil-off rate BOR_{LNG} and inputs from the ship's Steam Heat Balance and Flow Diagram, P_{BOG} can be determined.

Steam Heat Balance and Flow Diagram provides the Fuel Oil Consumption at Different Power Levels in kg/h (minimum 4 points) or the corresponding fuel oil rate in g/kWh. The Fuel

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Oil Consumption is converted to Daily LNG Consumption using the ratio of the Lower Calorific values as stated by IMO in MEPC.308 (73).

Daily LNG consumption (tons LNG/day) is calculated at the different power levels as follows:

$$LNG\ Consumption = \frac{Fuel\ Oil\ Consumption\ (\frac{kg}{h})\cdot 24}{1000} \cdot \frac{LCV_{FO}}{LCV_{LNG}}\ (\frac{tons}{day})$$

P_{BOG} can be read from the relation between the calculated Daily LNG consumption and the corresponding power. Typical curves given as example in following figure.

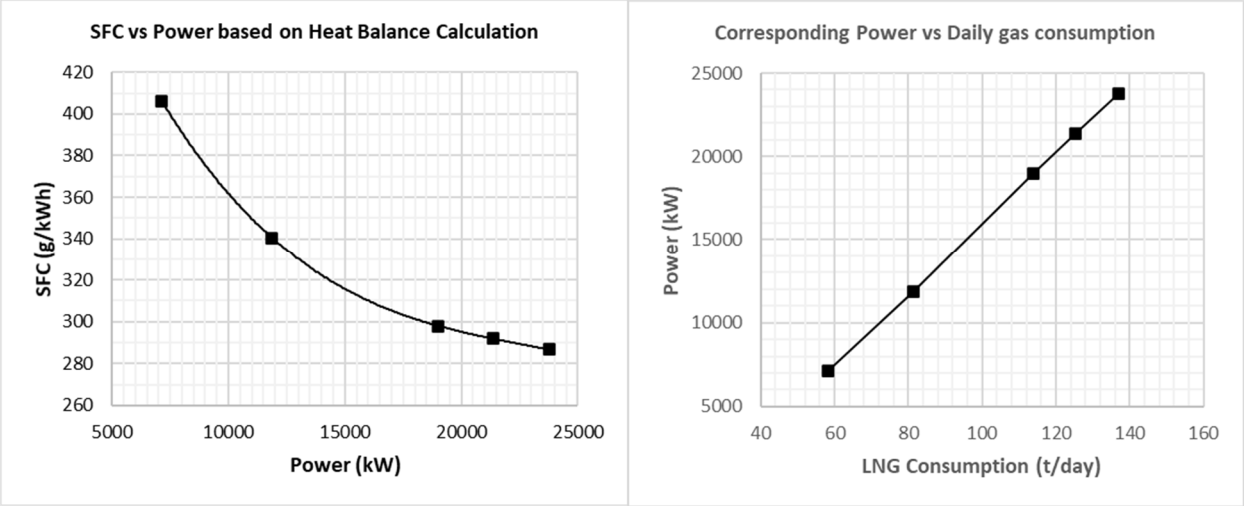

Figure 7.2.1 Example of SFC vs Power from heat balance and Corresponding Power vs Daily Gas Consumption curves for a typical steam ship.

Once the power of the ship's engine is limited, this results in a limited power, namely MCR_{lim}. The calculation of the MCR_{lim} is an iterative process as a reduction factor R_f *(* $R_f < 1$*)* shall be applied to the documented *MCR* until the *Attained EEXI* is less than or equal to the *Required EEXI*.

7.3 SGC for steam-turbine LNG Carriers

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) to be corrected to the value of LNG as per MEPC.308 (73) para 2.2.7.2.2. The FOC should be multiplied with the ratio of the lower calorific values (*LCV*) of the respective Fuel oil and LNG. Conversion of SFOC to SGC, is taken as follows:

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

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7.4 $V_{ref,app}$ for steam-turbine LNG Carriers

The formula for steam-turbine LNG carriers is to be as follows:

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

and in case of power limitation:

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

7.5 Calculation of Attained EEXI for Diesel Electric LNG Carriers

According to MEPC.333 (76) par. 2.2.1, the power from combustion of excessive natural boil-off gas in the engines or boilers to avoid releasing to the atmosphere or unnecessary thermal oxidation, should be deducted from $P_{ME(i)}$ with the approval of the verifier. This deduction is only acceptable if no reliquefication plant is installed. In case a reliquefication plant is installed then the additional auxiliary power to be used.

The below methodology considers LNG as the primary fuel. DFDEs are fitted with dual fuel auxiliary engines with no dedicated LNG fuel tanks.

The formula for the *Attained EEXI* for Diesel Electric LNG carriers is the below:

$$Attained\ EEXI = \frac{P_{ME}.\left(C_{FME_{Gas}}.SFC_{ME_{Gas}} + C_{FME_{Pilotfuel}}.SFC_{ME_{Pilotfuel}}\right) + P_{AE}.\left(C_{FAE_{Gas}}.SFC_{AE_{Gas}} + C_{FAE_{Pilotfuel}}.SFC_{AE_{Pilotfuel}}\right)}{Capacity\ .V_{ref}}$$

Simplified:

$$Attained\ EEXI = \frac{(P_{ME} + P_{AE}).\left(C_{FME_{Gas}}.SFC_{ME_{Gas}} + C_{FME_{Pilotfuel}}.SFC_{ME_{Pilotfuel}}\right)}{Capacity\ .V_{ref}}$$

This simplification is justified since DFDEs – do not have separate MEs & AEs but have a number of 4-stroke Dual Fuel Gensets all acting as MEs. Thus,

$\left(C_{FME_{Gas}}.SFC_{ME_{Gas}} + C_{FME_{Pilotfuel}}.SFC_{ME_{Pilotfuel}}\right)$ and $\left(C_{FAE_{Gas}}.SFC_{AE_{Gas}} + C_{FAE_{Pilotfuel}}.SFC_{AE_{Pilotfuel}}\right)$

are exactly the same.

In case of shaft power limitation (motor power limitation) and after deduction of the power from combustion of excessive natural boil-off gas, the formula changes as follows:

$$Attained\ EEXI = \frac{(P_{ME\_revised} + P_{AE}).\left(C_{FME_{Gas}}.SFC_{ME_{Gas}} + C_{FME_{Pilotfuel}}.SFC_{ME_{Pilotfuel}}\right)}{Capacity\ .V_{ref}(P_{MElim})}$$

The methodology cannot be applied prior to power limitation.

No. 172 (cont)

Nomenclature

MCR	Maximum Continuous Rating
MPP	Rated output of motor (kW)
P_{ME}	$0.83\ MPP\ /\ \eta_{electrical}$
Vref	Reference Speed
$\eta_{electrical}$	0.913
$SFC_{ME(i)\_electric,\ gas\ mode\ at\ 75\%\ of\ MCR}$	Certified specific fuel consumption, given in g/kWh, of the 4-stroke dual fuel gensets (considered as ME in this case), on gas mode
$SFC_{ME(i)\_Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at 75% MCR according to testbed result
C_F	Conversion factor between fuel consumption and CO2 emission, for LNG, C_F=2.750 t-CO2/t-Fuel
MPP_{lim}	The new MPP to which the motor must be limited to comply with the *Required EEXI*
P_{ME_lim}	$0.83\ MPP_{lim}\ /\ \eta_{electrical}$
R_f	Reduction factor *Rf (Rf < 1)* with $MCR_{lim} = R_f \cdot MCR$
P_{BOG}	Is the nominal power generated by consuming all boil-off gas from the cargo tanks
$P_{Excessive}$	The excessive power from combustion of excessive natural boil-off gas is defined as the difference between nominal power generated by consuming all boil-off gas from the cargo tanks and (MPP_{lim} / $\eta_{electrical}$ + P_{AE}), $P_{Excessive} = P_{BOG} - (MPP_{lim} / \eta_{electrical} + P_{AE})$
$P_{ME\_revised}$	The relevant power value after deduction of $P_{Excessive}$, This value will be used in the calculation of the *Attained EEXI*, $P_{ME\ revised} = 0.83\ MPP_{lim} / \eta_{electrical} - P_{Excessive}$
BOR_{LNG}	Daily boil-off rate, in t/day, $BOR_{LNG} = 0.000864 \cdot V_{Cargo}$
V_{Cargo}	Cargo Tank Volume as per capacity plan, in m^3

Based on the daily boil-off rate BOR_{LNG} and inputs from the Gensets NOx Technical File (Parent Engine), P_{BOG} can be determined. The SFC_{MEgas} to be used is the weighted average corresponding to the 75% of the engines' MCR values.

$$P_{BOG} = \frac{BOR_{LNG} \cdot 1000000}{SFC_{MEgas} \cdot 24} \text{ [kW]}$$

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Typical curve given as example in following figure.

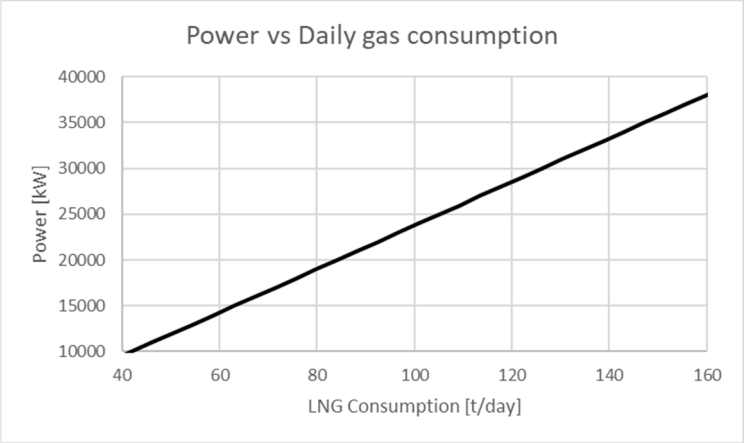

Figure 7.5.1 Example of daily LNG consumption vs Power for a typical DFDE ship.

Once the power of the ship's engine is limited, this results in a limited power, namely MPP_{lim}. The calculation of the MPP_{lim} is an iterative process as a reduction factor R_f *(R_f < 1)* shall be applied to the documented MPP until the *Attained EEXI* is less than or equal to the *Required EEXI*.

7.6 Primary Fuel

According to MEPC.308(73), in cases where the cruising time is defined, the primary fuel can be decided based on the corresponding gas volume and cruising time. However, in case where the cruising time is not defined, for LNG carriers with dual fuel engines (e.g. all the diesel-electric ships) LNG can be considered as primary fuel provided cargo tanks and engines/boilers are connected.

7.7 Reliquefaction Plants Considerations

All kind of reliquification plants to be considered according to MEPC.308(73) chapter 2.2.5.6.3 only in case that BOG cannot be used for propulsion or auxiliary engines. The following parameters can be sourced from the respective documents:

Parameter	Sourcing document
$COP_{cooling}$ is the coefficient of design performance of reliquefaction	Typically, 0.166 for $COP_{cooling}$ is used according to 2.2.5.6.3.1 of MEPC.308(73). Alternatively, a value calculated by the manufacturer and verified by the administration or RO according to the regulation 2.2.5.6.3.1 of MEPC.308(73).
$R_{reliquefy}$ is the ratio of boil-off gas (BOG) to be re-liquefied to entire BOG **$R_{reliquefy} = BOG_{reliquefy} / BOG_{total}$**	$BOG_{reliquefy}$ and density of BOG are derived from the ship's technical specification.
COP_{comp} is the design power performance of compressor	Typically, 0.33 is used according to the regulation 2.2.5.6.3.2 of MEPC.308(73). Alternatively, a value calculated by the manufacturer and verified by the administration or RO according to the regulation 2.2.5.6.3.2 of MEPC.308(73).

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