

**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)

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## 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:

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

\* 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,

$V_{ref}$

$V_{ref,avg}$  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:

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

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:

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

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 *SFCs* listed in an applicable test report included in an approved NO<sub>x</sub> Technical File of the main engine as defined in paragraph 1.3.15 of the NO<sub>x</sub> 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<sub>x</sub> 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<sub>F</sub> ; Conversion factor between fuel consumption and CO<sub>2</sub> emission

For those engines which do not have a test report included in the NO<sub>x</sub> 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:

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

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:

$$f_{jRoRo} = \frac{1}{F_{nL}^{\alpha} \cdot \left(\frac{L_{pp}}{B_S}\right)^{\beta} \cdot \left(\frac{B_S}{d_S}\right)^{\gamma} \cdot \left(\frac{L_{pp}}{V^{1/3}}\right)^{\delta}} \quad ; \text{ if } f_{jRoRo} > 1 \text{ then } f_j = 1$$

where the Froude number,  $F_{nL}$ , is defined as:

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

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

and the exponents  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$  are defined as follows:

| Ship type            | Exponent: |         |          |          |
|----------------------|-----------|---------|----------|----------|
|                      | $\alpha$  | $\beta$ | $\gamma$ | $\delta$ |
| 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:

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

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<br>where DWT ≤ 80,000<br>80,000<br>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  $MPP_{avg}$  ( $= D \times E^F$ )

| 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<br>where DWT ≤ 95,000<br>95,000<br>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                                             | $\geq 10,000$ DWT | From 1 January 1999 to 1 January 2009   | Conventional                   | 2,433      |
| Gas carrier                                              | $\geq 2,000$ DWT  |                                         | Conventional                   | 292        |
| Tanker                                                   | $\geq 4,000$ DWT  |                                         | Conventional                   | 3,345      |
| Containership                                            | $\geq 10,000$ DWT |                                         | Conventional                   | 2,185      |
| General cargo ship                                       | $\geq 3,000$ DWT  |                                         | Conventional                   | 1,673      |
| Refrigerated cargo carrier                               | $\geq 3,000$ DWT  |                                         | Conventional                   | 53         |
| Combination carrier                                      | $\geq 4,000$ DWT  |                                         | Conventional                   | 3,351      |
| LNG carrier                                              | $\geq 10,000$ DWT | From 1 January 1998 to 31 December 2010 | Conventional, Non-conventional | 185        |
| Ro-ro cargo ship (vehicle carrier)                       | $\geq 10,000$ DWT |                                         | Conventional                   | 301        |
| Ro-ro cargo ship                                         | $\geq 1,000$ DWT  |                                         | Conventional                   | 188        |
| Ro-ro passenger ship                                     | $\geq 250$ DWT    |                                         | Conventional                   | 350        |
| Cruise passenger ship having non-conventional propulsion | $\geq 25,000$ 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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