OPERATIONAL CARBON INTENSITY INDICATORS

Relevant for ship owner and managers

TI - 21- 08 Dec. 2021

Refer to the Marine Environment Protection Committee (MEPC 76), 10 to 17 June 2021 (remote session), some amendments on MARPOL annex VI and technical guidelines in relation to the operational carbon intensity indicator (CII) annual rating scheme adopted.

A key decision on the meeting was establishment of CII reduction factor on the basis of 2019 reference lines. In addition, the CII rating is defined (the gap between attained CII and required CII) which categorized in five divisions. (A to E)

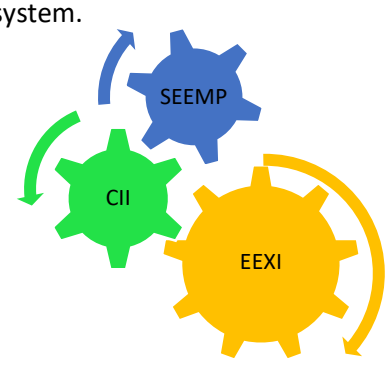
This technical information describes a brief history of IMO GHG reduction strategy and CII requirement based on the latest amendment.

Introduction

In 2018, IMO adopted an initial strategy on reduction on GHG emissions from international shipping. (MEPC. 304(72))

This strategy predicts after implementation of the planned measures, the CO_2 emissions per transport work will be reduced as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008.

On June 2021, the IMO adopted some new CO_2 mandatory regulations applicable to existing ships. The Energy Efficiency Existing Ship Index (EEXI) addressing the technical efficiency of ships, the Carbon Intensity Indicator (CII) rating scheme addressing the operational efficiency, and the enhanced Ship Energy Efficiency Management Plan (SEEMP) addressing the management system.



EEXI is a design index and will be calculated based on the same formula of the EEDI calculation method.

Operational Carbon Intensity Indicator (CII) rating scheme is an operational index to reduce the CO2 emission per transport work, based on the IMO strategy short term target. (improvement the international shipping efficiency at least 40% compared to 2008)

By the end of 2022, each ship should indicate on SEEMP, the calculation method of annual CII from 2023 calendar year and reporting procedure of CII.

Operational Carbon Intensity Indicator

CII is an operational rating approach which calculated based on the operational fuel consumption data.

Attained CII

For all ships[1] of 5000 GT & above engaged in international voyages, the attained CII should be calculated based on the annual DCS (IMO Date Collection System) report.

[1] Bulk carrier, Gas carrier (LPG carrier), Tanker, Containership, General cargo ship, Refrigerated cargo carrier, Combination carrier, Ro-ro cargo ships (Vehicle carrier), Ro-ro cargo ship, Ro-ro passenger ship, LNG carrier and Cruise passenger ship

$$Atteined\ CII_{ship} = \frac{M}{W}$$

$$M = FC_j \times C_{F_j}$$

"j" is the fuel oil type
FC_j is the total mass (in grams) of consumed fuel oil of type 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.

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:

$$W_s = C \times D_t$$

C represents the ship's capacity:

- For bulk carriers, tankers, container ships, gas carriers, LNG carriers, ro-ro cargo ships, general cargo ships, refrigerated cargo carrier and combination carriers (C = DWT)
- For cruise passenger ships, ro-ro cargo ships (vehicle carriers) and ro-ro passenger ships, gross tonnage (C = GT)

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

Required CII

The required CII is calculated by multiplying the adopted annually reduction factor by CII reference line which specified based on the ship types.

Year	Reduction Factor
2023	5%
2024	7%
2025	9%
2026	11%
2027-2030	To be decided

Table 1 – Reduction factor (Z)

Method to develop the CII reference lines:

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

$$CII_{Ref} = a\ Capacity^{-c}$$

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. 2;

Ship type		Capacity	a	c
Bulk carrier	279,000 DWT & above	279000	4745	0.622
	less than 279,000 DWT	DWT	4745	0.622

Table 2: Sample of Parameters for determining the 2019 ship type specific reference lines (bulk carriers)

In accordance with regulation 28 of MARPOL Annex VI, the required annual operational CII for a ship is calculated as follows:

Required annual operational CII=
(1-Z/100) x CII $_{Ref}$

The operational CII rating

An operational energy efficiency performance rating should be annually assigned 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.
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.

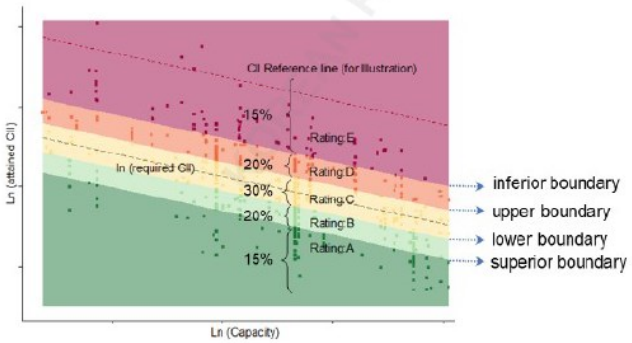


Figure 1 – Boundaries & ratings

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, the lower 20% and further lower 15% of the individuals are to be assigned rating B and A respectively, as illustrated in figure 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.

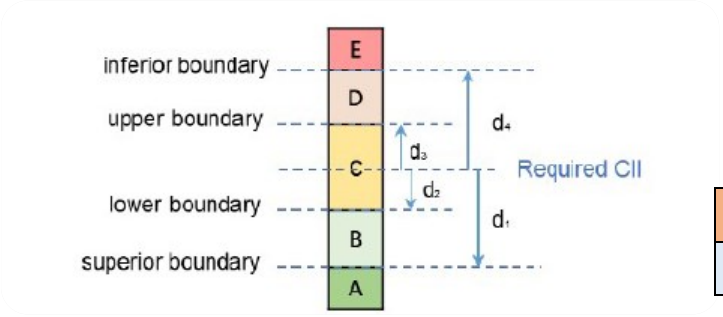


Figure 2 - dd vectors and rating bands

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

$$ln(attained\ CII) = \delta^p - c\ ln(Capacity) + \varepsilon^p$$

$$p = \{0.15\ or\ 0.35\ or\ 0.5\ or\ 0.65\ or\ 0.85\}$$

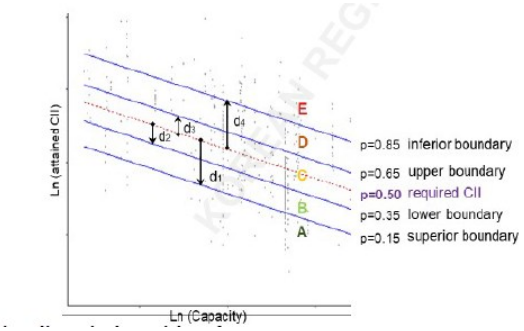


Figure 3 – Quantile regression lines in logarithm form

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:

$$\begin{cases} Superior\ boundary = e^{d_1} \times required\ CII \\ Lower\ boundary = e^{d_2} \times required\ CII \\ Upper\ boundary = e^{d_3} \times required\ CII \\ Inferior\ boundary = e^{d_4} \times required\ CII \end{cases}$$

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

Ship type	Capacity	*dd* vectors			
		e^{d1}	e^{d2}	e^{d3}	e^{d4}
Bulk carrier	DWT	0.86	0.94	1.06	1.18

Table 3 - The estimated dd vectors (bulk carriers)

By comparing the attained annual operational CII of a specific ship with the four boundaries, a rating can then be assigned.