# Ship Energy Efficiency Management Plan (SEEMP)

## (Part III - Ship Operational Carbon Intensity Plan)

(*** Shipping )

| | |
|---|---|
| Name of vessel | |
| IMO NO. | |

# Explanatory notes

This guidance was developed to assist in the preparation of the Ship Energy Efficiency Management Plan ("SEEMP") required by regulation 26 of MARPOL Annex VI and was prepared in accordance with Resolution MEPC.346 (78).

We have made every effort to ensure that the information contained in this guidance is accurate, but please note that there is possibility of unintended mistranslations and errors in the content, and the content in this plan should be written and modified to suit the actual situation of the ship.

# Contents

## 1. Review and update log

| Date/timeline | Updated parts | Developed by | Implemented by |
|---|---|---|---|
| 01 October 2022 | Initial establishment | HONG GIL DONG | On-board: Master, Chief Engineer and Crew<br>On-shore: Mr. XYZ |
| <2nd time> | | | |
| Etc. | | | |
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## 2. Ship Particular and CII

| | | | |
|---|---|---|---|
| **Name of the ship** | XYZ | **IMO number** | 9XXXXXX |
| **Company** | XXX Shipping Line | **Year of delivery** | 2012 |
| **Flag** | Republic of Korea | **Ship type** | Bulk carrier |
| **Gross tonnage** | 40000 | **DWT** | 75500 tons |
| **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): |
|---|---|---|---|---|
| **2022** | 4.255 | N/A | N/A | N/A |
| **2021** | 4.299 | 3.862 | 3.862 | B |
| **2020** | 4.343 | 3.867 | 3.867 | B |

| | Required Annual Operational CII |
|---|---|
| **2023** | 4.168 |
| **2024** | 4.080 |
| **2025** | 3.992 |

# 3. Calculation Methodology of CII

## 3.1 Description

This part describes the calculation methodology of the ship's attained annual CII, including required data and how to obtain these data as far as not addressed in SEEMP Part II.

## 3.2 Calculation methodology of the Ship's attained annual CII

- The attained annual operational CII of individual ships is calculated as the ratio of the total mass of $CO_2$($FC_j \times C_{F_j}$) emitted to the total transport work($C \times D_t$) undertaken in a given calendar year, as follows:

$$attained\ CII_{ship} = \frac{\sum(FC_j \times C_{F_j})}{C \times D_t}$$

- $j$ is the fuel oil type;
- $FC_j$ is the total mass (in grams) of consumed fuel oil type $j$ in the calendar year, as reported under IMO DCS;
- $C_{F_j}$ represents the fuel oil mass to CO2 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 EEDI for new ships(resolution MEPC.308(73);
- $C$ represents the ship's capacity:

  For bulk carriers, container ships, Gas carriers, LNG carriers, General cargo ships, refrigerated cargo carrier and combination carriers, deadweight tonnage(DWT) should be used as Capacity;
  For cruise passenger ships, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships and ro-ro passenger ships, gross tonnage(GT) should be used as Capacity;

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

## 3.3 Correction Factors and Voyage Adjustments for CII Calculations

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

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

- 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.

- The correction factors should be applied according to Appendix Ⅱ.

## 3.4 Trial CII Calculations

- The following metrics can be used for trial purposes, where applicable:

  a. Energy Efficiency Performance Indicator(EEPI)

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

  b. cbDIST

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

  c. clDIST

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

  d. 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.
  - $D_l$ 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.

# 4. Three-year Implementation Plan

## 4.1 Description

- The list of measures has been considered and will be implemented to achieve the required annual CII over the next 3 years.
- The timeline and method of the implementation plan were established and the responsible personnel of the company was designated for each planned task.
- Possible impediments were found when the listed measures are implemented; and the possible contingency measures were made up to overcome these impediments.
- The documentation was attached to support the substantiality of the described measures, including the simulation result of the ship's expected CII calculation.

## 4.2 List of measures to be considered and implemented

| Measure | Impact on CII | Time and method of implementation and responsible personnel | | | Impediments and contingency measures | |
|---|---|---|---|---|---|---|
| Weather routing | XX-XX% reduction | Milestone | Due | PIC | Impediment | Contingencies |
| | | Install system onboard | 1 Feb 2023 | Superintendent | The effectiveness is trade area and route dependent. | N/A |
| | | Train crew | 1 June 2023 | Crew manager | Less effective during slow steaming | Consider in conjunction with speed optimization |
| Speed optimization | XX-XX% reduction | Milestone | Due | PIC | Impediment | Contingencies |
| | | Maximum speed is set at 60% MCR/17.0 kt | 1 Feb 2024 | Master | Less effective in combination with other measures | Consider effect in conjunction with other measures |
| Optimum propeller | XX-XX% reduction | Milestone | Due | PIC | Impediment | Contingencies |
| | | Analyze the effect of possible propellers and devices | 1 Jun 2025 | Technical manager | Analysis may show that the measure is not effective | Cancel project |
| | | If viable, install at next drydocking | 1 Oct 2025 | Superintendent | Less effective during slow steaming | Consider in conjunction with speed optimization |
| … | … | … | | | … | |

**[Informative]**

Following energy efficiency measures and abatement technologies can be considered to maintain the required CII over the next three-year.

| Type | Group | Abatement technologies and the use of alternative fuels, renewable energy |
|---|---|---|
| Operation and management measures | Fuel-efficient operations | Improved voyage planning<br>Weather routeing<br>Just in time<br>Speed optimization<br>Optimized shaft power |
| | Optimized ship handling | Optimum trim<br>Optimum ballast<br>Optimum propeller and propeller inflow considerations<br>Optimum use of rudder and heading control system(autopilots) |
| | Fleet and cargo | Improved fleet management<br>Improved cargo handling<br>Energy management |
| Energy-saving technologies | Main engine improvements | Main Engine Tuning<br>Common-rail<br>Electronic engine control |
| | Auxiliary systems | Frequency converters<br>Speed control of pumps and fans |
| | Steam plant improvements | Steam plant operation improvements |
| | Waste heat recovery | Waste heat recovery<br>Exhaust gas boilers on auxiliary engines |
| | Propeller improvements | Propeller-rudder upgrade<br>Propeller upgrade (nozzle, tip winglet)<br>Propeller boss cap fins<br>Contra-rotating propeller |
| | Propeller maintenance | Propeller performance monitoring<br>Propeller polishing |
| | Air lubrication | Air lubrication |
| | Hull coating | Low-friction hull coating |
| | Hull maintenance | Hull performance monitoring<br>Hull brushing<br>Hull hydro-blasting<br>Dry-dock full blast |
| | Optimization of water flow hull openings | Optimization water flow hull openings |
| | Super light ship | Super light ship |
| | Reduced auxiliary power demand | Reduced auxiliary power demand (low energy lighting etc.) |
| Use of renewable energy | Wind power | Towing kite<br>Wind power (fixed sails or wings)<br>Wind engine (Flettner rotor) |
| | Solar panels | Solar panels |
| Use of alternative fuels | Use of alternative fuel with carbons | LNG+ICE or FC<br>Methanol + ICE<br>Ethanol + IC |
| | Use of alternative fuel | Hydrogen + ICE or FC |

| | | |
|---|---|---|
| | without carbons | Ammonia + ICE or FC<br>Synthetic methane + ICE or FC<br>Biomass methane + ICE or FC<br>Synthetic methanol + ICE<br>Biomass methanol + ICE<br>Synthetic ethanol + ICE<br>Biomass ethanol + ICE |

### 4.3 Effect of the measures

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

| Year | Targeted rating | Required annual operational CII | Targeted operational annual CII |
|---|---|---|---|
| 2023 | C | 4.168 | 4.168 |
| 2024 | C | 4.080 | 4.080 |
| 2025 | C | 3.992 | 3.992 |

# 5. Self-evaluation and improvement

## 5.1 Description

- The person charge is responsible for establishing the procedures and methods of the self-evaluation for evaluating the effectiveness of the measures aimed to achieve required annual operational CII at the planned milestone, and for supplementing and improving it.

- The company better understand the overall characteristics of a ship by identifying the effectiveness and cause of measures through self-evaluation. In addition, it is possible to establish an improved management plan that can provide opportunities for energy efficiency and carbon emission reduction by analyzing the trend of efficiency improvement.

- CII (AER/cgDIST) can be likely used as the quantitative performance indicator for self-evaluation. The trial CII (EEPI, cbDIST, clDIST, EEOI) can be additionally considered, if convenient and/or beneficial for a ship. The monitoring toll should be calculated accurately according to Appendix X.

- The self-evaluation should be implemented periodically at least ○ *times a year*, by using real operational data collected through monitoring.

- In the evaluation, the effectiveness of each measure can be quantitatively calculated based on the goal and the results of the implemented measures, and the following factors can be additionally reviewed for a deepen understanding:

  e. timeline for starting the review process

  f. measures to address deficiencies and discrepancies

  g. where relevant, actions that will be taken to bring the ship back into better CII ratings

  h. where relevant identification if an action plan is required and identification of critical factors that contributed to missing the CII target

- All records related to the implementation for self-evaluation and improvement shall be documented and maintained for at least ○ *years* on board or onshore office.

# 6. Plan of corrective actions(if applicable)

## 6.1 Description

- As this ship had been *rated E for 20XX or rated as D for three consecutive years*, a revised SEEMP Part III was developed including a plan of corrective actions.
- This plan of corrective actions was developed by PIC at ship and shore after discussing the followings:
  a. Analysis of the cause for the inferior CII rating
  b. Analysis of the performance of implemented measures
  c. List of additional measures and revised measures to be add to the implementation plan
  d. Work carried out by the company responsible person for the added and revised measures in the implementation plan
  e. Possible impediments to the effectiveness of the measures for improving CII of the ship, including possible additional contingency measures
- All measures had been evaluated whether Specific, Measurable, Achievable, Realistic and Time bound and were enough to be actually implemented.
- The implementation of the plan of corrective actions would be monitored monthly basis and the additional measure will be considered to strengthen corrective actions in case of insufficient improvements for CII.

## 6.2 Analysis of causes for inferior CII rating

| Cause | Analysis of effect | Actions |
|---|---|---|
| Long anchoring period | There was only fuel oil consumption and no distance travelled during 15 days, it increased the figures of attained CII. | Collaborating with Port and ship agent, the ship will try to arrive at port Just in time. |
| High speed operation requested by charterer | Fuel oil consumption was increased and it made increase of attained CII and inferior CII Rating. | The PIC in ship management company will make effort to convince charterer to encourage the ship operate at optimum speed. |
| Adverse weather during voyage | Ship had to escape from the typhoon, it made much more fuel oil consumption on Main engine. | The ship will keep following the latest weather forecast and consider following the best route recommended by weather forecast company. |
| … | … | … |

### 6.3 Analysis of measures in the implementation plan

| Measure | Analysis of effect | Actions |
|---|---|---|
| Speed optimization | It was failed because the charter requested to operate the ship with maximum speed. | The PIC in ship management company will make effort to convince charterer to encourage the ship operate at optimum speed. |
| Fuel additives | The fuel additives were added on the fuel tank, but the ship could not get improvement on fuel savings. | Chief engineer reported it to company and PIC in company will ask supplier the cause. |
| Solar cell | Solar was out of order during the 20XX years, and it was not able to make electricity. | The maker was reported and they are keep trying to repair it. |
| … | … | … |

### 6.4 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 | |
|---|---|---|---|---|---|---|
| Hull maintenance | XX-XX% | Milestone | Due | PIC | Impediment | Contingencies |
| | | Propeller and hull cleaning with robot at berth | Feb 2024 | Superintendent | Check whether the port allows to cleaning | Cancel project |
| Alternative Fuel | XX-XX% | Milestone | Due | PIC | Impediment | Contingencies |
| | | Using biofuel | June 2024 | Superintendent and Chief engineer | Improper operation | Train crew |
| … | … | … | | | … | |

# Appendix Ⅰ. STANDARDIZED DATA REPORTING FORMAT

## <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 | |
| CII for trial purpose(non, one or more on voluntary basis) | | ☐ EEPI ☐ cbDIST ☐ clDIST ☐ EEOI | |
| Attained annual operational CII before any correction factors (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 (gCO2/dwt.nm) | | | |
| cbDIST (gCO2/berth.nm) | | | |
| cbDIST (gCO2/m.nm) | | | |
| EEOI (gCO2/t.nm or others) | | | |
| Method used to measure fuel oil consumption | | | |
| Fuel oil consumption (t) | (Cf ;..) | | |
| | Other (…….) | | |
| | Ethanol (Cf: 1.913) | | |
| | Methanol (Cf: 1.375) | | |
| | LNG (Cf: 2.750) | | |

| | | |
|---|---|---|
| | LPG (Butane) (Cf: 3.030) | |
| | LPG (Propane) (Cf: 3.000) | |
| | HFO (Cf: 3.114) | |
| | LFO (Cf: 3.151) | |
| | Diesel/Gas Oil (Cf: 3.206) | |
| Hours underway (h) | | |
| Distance Travelled (nm) | | |
| Power output (rated power) (kW) | Main Propulsion Power | |
| | Auxiliary Engine(s) | |
| Ice class (if applicable) | | |
| DWT | | |
| NT | | |
| Gross Tonnage | | |
| Ship type | | |
| IMO number | | |
| End date for DCS (dd/mm/yy) | | |
| Start date for DCS (dd/mm/yy) | | |

# Appendix Ⅱ. Voyage Adjustment or Correction Factors

**This table is based on RESOLUTION MEPC.355(78).**

| Correction factor | Description | Additional equation | Remark |
|---|---|---|---|
| $j$ | the fuel type | | |
| $C_{F_j}$ | the fuel mass to CO2 mass conversion factor for fuel type $j$, in line with those specified in resolution MEPC.308(73) | | |
| $FC_j$ | the total mass of consumed fuel of type $j$ in the calendar year, as reported under IMO DCS, converted to grams | | |
| $FC_{voyage,j}$ | the mass 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: | In cases where $FC_{voyage,j}$ is used<br>.1 Any associated distance travelled must also be deducted using $D_x$;<br>.2 The ship should report data for the deductions associated with voyage adjustments to the Administration. | scenarios specified in regulation 3.1 of MARPOL Annex VI, which may endanger safe navigation of a ship<br>sailing in ice conditions, which means sailing of an ice-classed ship in a sea area within the ice edge. |
| $TF_j$ | the quantity of fuel $j$ removed for STS or shuttle tanker operation:<br>$TF_j = (1 - AF_{Tanker}) \cdot FC_{S,j}$ | | where $FC_{S,j} = FC_j$ for shuttle tankers and $FC_{S,j}$ is total quantity of fuel $j$ used on STS voyages for STS vessels.<br>If $TF_j > 0$ then $FC_{electrical,j} = FC_{boiler,j} = FC_{others,j} = 0$; |
| $y_i$ | consecutive numbering system starting at $y_{2023} = 0$, $y_{2024} = 1$, $y_{2025} = 2$, etc; | | |
| $f_i$ | the capacity correction factor for ice-classed ships | | EEDI correction factors can be applied provided they are included in ship's EEDI Technical file or EEXI Technical File. |
| $f_m$ | the factor for ice-classed ships having IA Super and IA | | EEDI correction factors can be applied provided they are included in ship's EEDI Technical file or EEXI Technical File. |

| | | | | |
|---|---|---|---|---|
| $f_c$ | the cubic capacity correction factors for chemical tankers | | | EEDI correction factors can be applied provided they are included in ship's EEDI Technical file or EEXI Technical File. |
| $f_{iVSE}$ | the correction factor for ship specific voluntary structural enhancement | | | EEDI correction factors can be applied provided they are included in ship's EEDI Technical file or EEXI Technical File. |
| $Capacity$ | deadweight or gross tonnes as defined for each specific ship type in CII Reference Lines Guidelines(G2) | | | |
| $D_t$ | the total distance travelled, as reported under IMO DCS | | | |
| $D_x$ | distance travelled for specific voyage ($FC_{voyage,j}$) | | | |
| $AF_{Tanker}$ | STS(ship to ship) transfer operation | | $AF_{Tanker,STS} = 6.1742 \times DWT^{-0.246}$ | Where $AF_{Tanker,STS}$ is applied, $FC_{eletrical}$, $FC_{boiler}$ and $FC_{others}$ should not be used. |
| | Shuttle tankers | | $AF_{Tanker,Shuttle} = 5.6805 \times DWT^{-0.208}$ | Where $AF_{Tanker,Shuttle}$ is applied, $FC_{eletrical}$, $FC_{boiler}$, $FC_{others}$ and $AF_{Tanker,STS}$ should not be used. |
| $FC_{electrical}$ | Estimated fuel consumption attributed to in use refrigerated Containers | have the ability to monitor reefer electrical consumption | $FC_{eletrical_{reefer,j}} = Reefer\ kWh \times SFOC$ | · SFOC is 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 NOx Technical file. |
| | | do not have the ability to monitor reefer electrical consumption | $FC_{eletrical_{reefer,j}} = C_x \cdot 24 \cdot SFOC_{avg} \cdot (Reefer_{days_{sea}} + \sum Reefer_{days_{port}})$ | · $c_x$ is a default reefer consumption, 2.75 kW/h<br>· SFOC is 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 NOx Technical file.<br>· $Reefer_{days_{port}} = \frac{No_cArrival + No_cDeparture}{2} \times Days_{port}$ |

| | | | |
|---|---|---|---|
| | Estimated fuel consumption attributed to Cargo cooling Systems on Gas carriers and LNG carriers | $FC_{eletrical_{cooling},j} = Cooling\ kWh \times SFOC$ | · $Cooling\ kWh$ is measured on the vessel by the kWh meter counter on the vessel<br>· SFOC is fuel consumption in g/kWh associated with the relevant source of electrical power as per the EEDI/EEXI Technical file or the NOx Technical file. |
| | Electric Cargo discharge pumps on tankers | $FC_{eletrical_{discharge},j} = Discharge\ kWh \times SFOC$ | · $Discharge\ kWh$ is measured on the vessel by the kWh meter counter on the vessel<br>· SFOC is fuel consumption in g/kWh associated with the relevant source of electrical power as per the EEDI/EEXI Technical file or the NOx Technical file. |
| $FC_{Boiler,j}$ | the mass of fuel of type $j$, consumed by oil fired boiler for the purposes of cargo heating and cargo discharge on tankers | | $FC_{Boiler,j}$ should be measured by accepted means, e.g. tanks soundings, flow meters. |
| $FC_{others,j}$ | the mass of fuel of type $j$, consumed by standalone engine driven cargo pumps during discharge operations on tankers | | $FC_{others,j}$ should be measured by accepted means, e.g. tanks soundings, flow meters. |
| $AF_{PT}$ | The port time correction factor for cruise passenger ships only | $AF_{PT} = (1.8 - \frac{Hours\ Under\ Way}{Hours\ In\ Operation})$ | For cruise passenger ships where<br>$\frac{Hours\ Under\ Way}{Hours\ In\ Operation} \geq 0.8, AF_{PT} = 1$ |

# Appendix Ⅲ. Sample of Self-evaluation and Improvement(IF APPLICABLE)

| Prepared by | Approved by | |
|---|---|---|
| | | Implementation Date : 202X.XX.XX |

## 1. Performance goal and evaluation result

### ▶ CII

- Weather routing

| Period | Goal | Evaluation | Difference |
|---|---|---|---|
| | | | |
| | | | |
| Final result | | | XX % |

### ▶ Trial CII(EEOI, EEPI,…)

- Weather routing

| Period | Goal | Evaluation | Difference |
|---|---|---|---|
| | | | |
| | | | |
| Final result | | | XX % |

## 2. Improvement

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