



CHINA CLASSIFICATION SOCIETY

RULES FOR GREEN ECO-SHIPS

2020

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FOREWORD

The Rules aims to advocate the development and application of green technologies, promote the structural optimization and upgrading of shipbuilding, related manufacturing and shipping industries, promote the use by shipping companies of cost-effective technologies and management measures to new and existing ships so as to improve the energy saving and environmental protection levels of their fleets and, with safety as the precondition, achieve the goals of low energy consumption, low emissions, low pollution and comfortable working and living environment for their ships.

A green eco-ship means a ship which uses advanced technologies to safely satisfy its intended functions and performance within its life cycle, meanwhile can improve energy efficiency, reduce greenhouse gas^① (GHG) emission, minimize or eliminate the harmful effect on human health and the pollution and damage on ecological environment, enhance effective recycling of resources.

A green eco-ship covers two main elements of environmental protection and ecological protection.

(1) Environmental protection: mainly including the following aspects: discharge control of various water pollutants (e.g. oil, chemicals, sewage and grey water, garbage from ships, etc.) and emission control of air pollutants (e.g. nitrogen oxides (NO_x), sulphur oxides (SO_x), particulate matter (PM), ozone-depleting substances (ODS), volatile organic compounds (VOCs), etc.), and control of the use of harmful materials (e.g. harmful anti-fouling system(AFS), asbestos, etc.) .

(2) Ecological protection: mainly including the following aspects: emission control of GHG (with CO₂ and HFCs, etc. as the emission control targets) which has impact on climate change, prevention of transfer of invasive organisms from ballast water and biofouling, and environmental friendliness (e.g. comfort onboard (vibration, compartment noise, indoor climate), underwater noise and ambient noise).

The goals of a green eco-ship include the following:

(1) The goal of environmental protection: Prevention and reduction of pollution or damage caused by ships to water, land and air , and promotion of the recycling of resources.

(2) The goal of ecological protection: Prevention and reduction of adverse effects caused by ships on climate change, aquatic ecological environment and human health.

The functional requirements for achieving the goals of green eco-ships consist of:

(1) Basic safety requirements:

1) The strength, integrity and stability of ships in both intact and damaged conditions are to be adequate, and the construction and arrangement, machinery and electrical installations/systems, and safety equipment are to be suitable for the safe operation of ships.

2) The application of any green ecological technology to ships is not to reduce the original safety level of ships.

(2) The functional requirements for achieving the goal of environmental protection:

^① Greenhouse gas (GHG) includes six types of greenhouse gases specified in the Kyoto protocol: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbon (PFCs) and sulfur hexafluoride (SF₆). For the purpose of the Rules, the control of CO₂ is the main objective. Emission control of HFCs, being regarded as ozone-depleting substances, is categorized as a sub-element of air pollutants emission control.

1) Ships are to meet all applicable requirements of IMO conventions related to environmental protection (MARPOL Convention, AFS Convention and Hongkong Ship recycling Convention) or the Regulations for the Statutory Surveys of Ships and Offshore Installations (Technical Regulations for the Statutory Surveys of Sea-Going Ships Engaged on Domestic Voyages) and in addition, further reduce risks of water pollutants discharge and air pollutants emissions in terms of equipment, arrangement, operations and maintenance through innovation and application of green ecological technology.

(2) Usage of materials harmless to humans and marine ecosystems are to be encouraged and promoted in the design, construction and repairs of ships.

(3) The functional requirements for achieving the goal of ecological protection:

1) The GHG emission from ships and energy consumption of ships is to be reduced by combining with design measures and effective operational control under the same capacity and speed.

2) The clean, low-carbon or zero-carbon energies are to be used to the maximum for the energies necessary for ship propulsion, accommodation and the normal operation of auxiliary machineries, under the premise of ship safety.

3) Ships are to meet all applicable requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (if applicable) and in addition, further reduce risks caused by harmful aquatic organisms and pathogens in ballast water through the innovation and application of green ecological technologies in equipment, arrangement and operations of the ship.

4) Ships are to take appropriate technical and operational measures to control and manage biofouling to prevent transfer of invasive aquatic species, and at the same time, to improve the operational energy efficiency of the ship.

5) The structure, the arrangement of compartments and the installation of equipment of ships are to be such as to minimize risks of ship-generated vibrations and noises endangering human health and improve the comfort of working and living environment onboard.

6) The arrangement of the equipment and design of propeller are to be such as to minimize the adverse impact of underwater radiated noise from ships on marine life. The arrangement of equipment and design of exhaust systems of main and auxiliary engines and boilers, ect. are to be such as to minimize the adverse impact of ambient noise from ships on residents on shore.

CHAPTER 1 GENERAL

1.1 General requirements

1.1.1 The Rules applies to sea-going ships for which CCS Green Eco-ship class notations are requested. The Rules include two parts, of which, Part I applies to sea-going ships engaged on international voyages, and Part II applies to sea-going ships engaged on domestic voyages. For sea-going ships not flying the flag of China intended for navigating in restricted service and engaged on non-international voyages, the requirements for ships engaged on domestic voyages may be referred to.

1.1.2 The Rules are part of CCS rules system. The purpose of the Rules is to encourage the design, construction and operation of the ships classed with CCS to a higher level of environmental and ecological protection, and to a more comfortable onboard working and living environment on the basis that international or national regulations on ship safety and environmental protection are complied with.

1.1.3 Ships, for which Green Eco-ship class notations are requested, are to comply with the applicable requirements of CCS Rules for Classification of Sea-going Steel Ships.

1.1.4 In addition, ships, for which Green Eco-ship class notations are requested, are to consider complying with the special requirements of the flag State Administration if any.

1.1.5 From the date of entry into force of the Rules, the CLEAN class notations for sea-going ships applying for classification with CCS will not be assigned. Ships for which CLEAN class notations have already been assigned or requested may proceed with the maintenance or assignment of CLEAN class notations according to the requirements of Chapter 8 of PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships, or may request for Green Eco-ship class notations to replace the CLEAN class notations in accordance with the applicable requirements of the Rules.

1.1.6 From the date of entry into force of the Rules, the Green Ship class notations and relevant class notations for sea-going ships applying for classification with CCS as specified in CCS Rules for Green Ships will not be assigned. Ships for which relevant class notations have already been assigned or requested according to CCS Rules for Green Ships may proceed with the maintenance or assignment of relevant class notations according to the applicable requirements of CCS Rules for Green Ships, or may request for Green Eco-ship class notations to replace the original class notations in accordance with the applicable requirements of the Rules.

1.2 Definitions and Terms

1.2.1 Definitions

1.2.1.1 Unless provided otherwise, for the purpose of the Rules:

(1) *Oil residue (sludge)* means the residual waste oil products generated during the normal operation of a ship such as those resulting from the purification of fuel or lubricating oil for main or auxiliary machinery, separated waste oil from oil filtering equipment, waste oil collected in drip trays, and waste hydraulic and lubricating oils.

(2) *Oily bilge water* means water which may be contaminated by oil resulting from things such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water.

(3) *Oil residue (sludge) tank* means a tank which holds oil residue (sludge) from which sludge may be disposed directly through the standard discharge connection or any other approved means of disposal.

(4) *Oily bilge water holding tank* means a tank collecting oily bilge water prior to its discharge, transfer or disposal.

(5) *Sewage (black water)* means:

- ① drainage and other wastes from any form of toilets and urinals;
- ② drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises;
- ③ drainage from spaces containing living animals; or
- ④ other waste waters when mixed with the drainages defined above.

(6) *Grey water* means drainage from dishwater, shower, laundry, bath and washbasin drains. It does not include drainage from toilets, urinals, medical premises and animal spaces, as defined in 1.2.1(5) of the Rules and drainage from cargo spaces.

(7) *Garbage* means all kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically.

(8) *Cargo residues* means the remnants of any cargo which are not covered by Annexes I, II and III to MARPOL Convention and which remain on the deck or in holds following loading or unloading, including loading and unloading excess or spillage, whether in wet or dry condition or entrained in wash water but does not include cargo dust remaining on the deck after sweeping or dust on the external surfaces of the ship.

(9) *Cooking oil* means any type of edible oil or animal fat used or intended to be used for the preparation or cooking of food, but does not include the food itself that is prepared using these oils.

(10) *Anti-fouling system* means a coating, paint, surface treatment, surface, or device that is used on a ship to control or prevent attachment of unwanted organisms.

(11) *Ballast water* means water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship.

(12) *Ballast Water Management System (BWMS)* means any system which processes ballast water such that it meets or exceeds the ballast water performance standard in regulation D-2. The BWMS includes ballast water treatment equipment, all associated control equipment, piping arrangements as specified by the manufacturer, control and monitoring equipment and sampling facilities. BWMS does not include the ship's ballast water fittings, which may include piping, valves, pumps, etc., that would be required if the BWMS was not fitted.

(13) *Noxious liquid substance (NLS)* means any substance indicated in the Pollution Category column of chapter 17 or 18 of the International Bulk Chemical Code, or specified in the present MEPC.2/Circular or provisionally assessed under the provisions of regulation 6.3 of MARPOL Annex II as falling into category X, Y or Z.

(14) *Biofouling* means the accumulation of aquatic organisms such as micro-organisms, plants, and animals on surfaces and structures immersed in or exposed to the aquatic environment. Biofouling can include microfouling and macrofouling. Macrofouling means large, distinct multicellular organisms visible to the human eye such as barnacles, tubeworms, or fronds of algae. Microfouling means microscopic organisms including bacteria and diatoms and the slimy substances that they produce. Biofouling comprised of only microfouling is commonly referred to as a slime layer.

(15) *Domestic Regulations* means Regulations for the Statutory Surveys of Ships and Offshore Installations (Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Non-International Voyages) and the amendments thereto, released by the Maritime Safety Administration under the Ministry of Transport, approved by the Ministry of Transport of the People's Republic of China.

(16) *Environmentally acceptable lubricants* mean lubricants that are biodegradable and minimally-toxic and are not bioaccumulative.

(17) *Greenhouse gas (GHG)* means any gas that absorbs and emits infrared radiation and exists in the atmosphere. For the purposes of the Rules, it refers to the carbon dioxide (CO₂) emitted from fossil fuels combustion of ships.

1.2.1.2 In addition to the above definitions, definitions given in relevant documents being referred to in the Rules, including IMO conventions, rules, guidelines and circulars, apply.

1.2.2 Terms and Abbreviations

1.2.2.1 The relevant terms of the Rules are abbreviated as follows:

(1) AFS: anti-fouling System;

(2) BC: black carbon;

(3) BWMP: ballast water management plan;

(4) BWMS: ballast water management system;

(5) CEEMC: Company Energy Efficiency Management Certificate;

(6) CO₂: carbon dioxide;

(7) DWT: dead weight tonnage;

(8) EEDI: energy efficiency design index;

(9) EGCS: exhaust gas cleaning system;

(10) FPSOs: floating Production, Storage and Offloading Units;

(11) FSUs: floating storage units;

(12) GHG: greenhouse gas;

(13) GT: gross tonnage;

(14) GWP: global warming potential;

(15) HFCs: hydrofluorocarbons;

(16) HVAC: heating ventilation and air conditioning system;

(17) IBC: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk;

- (18) IMO: International Maritime Organization;
- (19) ITTC: International Towing Tank Conference;
- (20) ISO: International Standardization Organization;
- (21) LNG: liquefied natural gas;
- (22) MARPOL: the International Convention for the Prevention of Pollution from Ships, 1973, developed by IMO, as modified by the Protocol of 1978 and the Protocol of 1997 relating thereto;
- (23) MEPC: the Marine Environment Protection Committee of IMO;
- (24) MSC: the Maritime Safety Committee of IMO;
- (25) NLS: noxious liquid substance;
- (26) NO_x: nitrogen oxides;
- (27) ODP: ozone depletion potential;
- (28) PM: particulate matter;
- (29) SEEMC: Ship Energy Efficiency Management Certificate;
- (30) SEEMP: Ship Energy Efficiency Management Plan;
- (31) SOLAS: the International Convention for the Safety of Life at Sea, 1974, and the 1988 Protocol relating thereto;
- (32) SO_x: sulfur oxides;
- (33) STS: transfer of oil cargo between oil tankers;
- (34) VOC: Volatile Organic Compounds.

1.3 Class Notations for Green Eco-ships

1.3.1 Class Notations for Green Eco-ships

1.3.1.1 Class notation for green eco-ships is a special identification of CCS classed ships complying with the relevant requirements of the two green elements of environmental protection and ecological protection. Class notations for green eco-ships for sea-going ships engaged on international voyages and domestic voyages are indicated as follows respectively:

Class Notations for Green Eco-ships

Table 1.3.1.1

	Class notation for environmental protection	Class notation for ecological protection
Sea-going ships engaged on international voyages:	G-EP	G-ECO
	G-EP (X)	G-ECO (X)
Sea-going ships engaged on domestic voyages:	Gd-EP	-
	Gd-EP (X)	Gd-ECO (X)

1.3.1.2 The class notations of ecological protection (G-ECO) and environmental protection (G-EP) for green eco-ships are to indicate that a sea-going ship engaged on international voyages is in compliance with relevant applicable international conventions and rules only.

1.3.1.3 The class notation of environmental protection (Gd-EP) for green eco-ships is to indicate that a sea-going ship engaged on domestic voyages is in compliance with relevant applicable domestic regulations only.

1.3.1.4 The class notations of environmental protection (G-EP (X) and Gd-EP (X)) and ecological protection (G-ECO (X) and Gd-ECO (X)) are to indicate further the levels of environmental protection and ecological protection by means of corresponding sub-elements listed in 1.3.2 and 1.3.3, where “X” represents a class notation of a sub-element for green eco-ships as described in Table 1.3.2 and 1.3.3.

1.3.1.5 The class notations of environmental protection (G-EP (X) and Gd-EP (X)) and the class notations of ecological protection (G-ECO (X) and Gd-ECO (X)) are independent from each other and can be assigned separately.

1.3.2 Class notations of ecological protection sub-elements for green eco-ships

1.3.2.1 Class notations of ecological protection sub-elements for green eco-ships are to indicate that the ship is in compliance with relevant technical requirements for ecological protection in the following three aspects: GHG emission control, prevention of transfer of invasive organism and environmental friendliness. Class notations of ecological protection sub-elements for sea-going ships engaged on international voyages and domestic voyages are shown in Table 1.3.2.1 below.

Class notations of ecological protection sub-elements for green eco-ships“X” Table 1.3.2.1

Class notation of ecological protection sub-element		Sea-going ships engaged on international voyages	Sea-going ships engaged on domestic voyages
GHG emission control*	CO ₂ emission design index	CDx	CDx
	CO ₂ emission operation management	COM	COM
Prevention of transfer of invasive organism	Class notation of ballast water management	BWM (T) BWM (Ex) BWM (O)	Not applicable
	Bio-fouling management	BIO	
Environmental friendliness	Comfort onboard (vibration)	VIBx	VIBx
	Comfort onboard (compartment noise)	NOIx	NOIx
	Comfort onboard (indoor climate)	CLx	CLx
	Underwater noise	UW	UW
	Ambient noise	RN	RN

*: GHG emission control includes CO₂ and HFCs. As HFCs is a kind of refrigerant used in ship refrigeration system, for the purpose of the Rules, it is grouped into air pollutant emission control.

1.3.2.2 Sea-going ships engaged on international voyages and domestic voyages assigned with class notations of ecological protection sub-elements as listed in Table 1.3.2 are to comply with technical requirements for corresponding class notations of sub-elements in Chapter 2 and Chapter 4 of the Rules respectively.

1.3.3 Class notations of environmental protection sub-elements for green eco-ships

1.3.3.1 Class notations of environmental protection sub-elements for green eco-ships are to indicate that the ship is in compliance with relevant technical requirements for environmental protection in the following three aspects: discharge control of water pollutants, emission control of air pollutants and control of use of harmful material. Class notations of environmental protection sub-elements for sea-going ships engaged on international voyages and domestic voyages are shown in Table 1.3.3.1 below.

Class Notations of Environmental Protection Sub-elements for Green Eco-ships“X” Table 1.3.3.1

Class notation of environmental protection sub-element		Sea-going ships engaged on international voyages	Sea-going ships engaged on domestic voyages
Control of discharge of Water pollutants	Control of discharge of oil pollutant	OILx, EAL, IBTS	OILx, EAL, IBTS
	Control of discharge of noxious liquid substances	NLSx	NLSx
	Control of discharge of sewage water	SC	SC
	Control of discharge of grey water	GWC	GWC
	Control of discharge of garbage	RC	RC
Air pollutant emission control	NO _x emission control	NECx	NECx
	SO _x /PM emission control	SEC	SEC
	VOC emission control	VCS, VCS-T	VCS, VCS-T
	Ozone-depleting substance emission control	RSCx	RSCx
	Emission control of shipboard incineration.	INC	INC
	Black carbon emission control	BC20, BC70	Not applicable
	Emission control of diesel engine exhaust pollutant	Not applicable	GBEC
Control of use of harmful material	Control of harmful anti-fouling system	AFS, AFS+	AFS, AFS+
	Control of harmful substances	GPR/GPR+, GPR (EU) / GPR (EU) +	GPR

1.3.3.2 Sea-going ships engaged on international voyages and domestic voyages assigned with class notations of environmental protection sub-elements listed in Table 1.3.3 are to comply with technical requirements for corresponding class notations of sub-elements in Chapter 3 and Chapter 5 of the Rules respectively.

1.4 Class notations for green eco-technologies

1.4.1 The Rules encourage ships to apply green eco-technologies, e.g. LNG fuels, low sulphur fuel oils, biofuels, high-voltage shore power, solar energy, wind energy, resistance reduction and emission control technologies, etc., in order to achieve the goals of environmental and ecological protection.

1.4.2 If a ship has applied relevant green eco-technologies and is in compliance with relevant technical requirements, the class notions of green eco-technologies may be assigned independent of the class notation of green eco-ships, as shown in Table 1.4.2.

Class Notations of Green Eco-technologies

Table 1.4.2

Green eco-technology	Class notations	Application scope	Technical requirements
Dual fuel diesel engine used as power plant	DFD	Applicable to liquefied gas carriers	CCS Guidelines for Design and Installation of Gas Fuel Engine Systems of Liquefied Gas Carriers
Gas fuel only engines used as power plant	GF	Applicable to liquefied gas carriers	CCS Guidelines for Design and Installation of Gas Fuel Engine Systems of Liquefied Gas Carriers
Natural gas used as fuel	Natural Gas Fuel	Applicable to non -liquefied gas carriers	CCS Rules for Natural Gas Fuelled Ships
Natural gas fuel ready system	DFDR	All ship types	CCS Guidelines for Natural Gas Fuel Ready Ships
SO _x emission control (Exhaust gas cleaning system)	SEC(EGCS)	All ship types	CCS Guidelines for Design and Installation of Exhaust Gas Cleaning Systems
Exhaust gas cleaning systems (EGC) Ready	EGC Ready(X)	All ship types	CCS Guidelines for Exhaust Gas Cleaning Systems Ready

Green eco-technology	Class notations	Application scope	Technical requirements
Low sulphur distillate fuels	LSDF	All ship types	CCS Guidelines for Use of Low Sulphur Distillate Fuels in Ships
NO _x emission control (Selective catalytic reduction system)	NEC(SCRS)	All ship types	CCS Guidelines for Application of Selective Catalytic Reduction (SCR) System Onboard Ships
Selective catalytic reduction system (SCR) Ready	SCR Ready(X)	All ship types	CCS Guidelines for Selective Catalytic Reduction System Ready
High-voltage shore connection system	AMPS	All ship types	Ch. 19, Pt. 8 of CCS Rules for Classification of Sea-going Steel Ships
Solar photovoltaic system	SPV	All ship types	Ch. 2 of CCS Guidelines for Survey of Solar Photovoltaic System and Lithium Iron Phosphate Battery System
Powered by battery only	Battery(Power)	All ship types	CCS Guidelines for Survey of Ships Powered by Battery Only
Hybrid power system	Hybrid	All ship types	CCS Guidelines for Survey of Ships Propelled by Hybrid Power, 2019
Fuel cell power system	FC-FULL	All ship types	CCS Guidelines for Ships Using Alternative Fuel, 2017
	FC-POWER 1		
	FC-POWER 2		
Propulsion system with sail assistance	WAP(RWS)	All ship types	CCS Guidelines for Application of Sail Technology, 2020
Air lubrication drag reduction system	ALDR	All ship types	CCS Guidelines for Survey of Air Lubrication Drag Reduction System, 2020

1.5 Assignment of class notations for green eco-ships and green eco-technologies

1.5.1 Assignment of class notations of green eco-ships and sub-elements

1.5.1.1 When a sea-going ship engaged on international voyages only complies with the applicable requirements of regulation 2.2 of Chapter 2 and/ or regulation 3.2 of Chapter 3 of the Rules, the class notation of ecological protection (G-ECO) and/or the class notation of environmental protection (G-EP) of green eco-ships may be assigned.

1.5.1.2 When a sea-going ship engaged on domestic voyages only complies with the applicable requirements of regulation 5.2 of Chapter 5 of the Rules, the class notation of environmental protection (Gd-EP) of green eco-ships may be assigned.

1.5.1.3 When a sea-going ship engaged on international voyages complies with, in addition to the requirements of regulation 2.2 of Chapter 2 of the Rules, the applicable requirements of regulations 2.3 to 2.5 of Chapter 2 of the Rules, the class notation of ecological protection (G-ECO(X)) may be assigned. Where “X” represents the class notation of a corresponding sub-element specified in regulations 2.3 to 2.5 of Chapter 2 of the Rules. If the ship satisfies the technical requirements of more than one sub-element, class notations of all of these sub-elements the technical requirements of which the ship fulfilled may be added in the suffix of the class notation of ecological protection. Examples are given in Table 1.5.1.3 below:

**Examples of Assignment of Class Notation of Ecological Protection for
a Sea-going Ship Engaged on International Voyages** **Table 1.5.1.3**

	Class notation of ecological protection	Class notation of a corresponding sub-element “X”
Sea-going ships engaged on international voyages	G-ECO (CD26)	CD26
	G-ECO (CD26, COM, BWM(T))	CD26, COM, BWM (T)
	G-ECO (CD26, COM, BWM(Ef), BIO, VIB2, CL1)	CD26, COM, BWM(Ef), BIO, VIB2, CL1

1.5.1.4 When a sea-going ship engaged on international voyages complies with, in addition to the requirements of regulation 3.2 of Chapter 3 of the Rules, the applicable requirements of regulations 3.3 to 3.5 of Chapter 3 of the Rules, the class notation of environmental protection (G-EP(X)) may be assigned. Where “X” represents the class notation of a corresponding sub-element specified in regulations 3.3 to 3.5 of Chapter 3 of the Rules. If the ship satisfies the technical requirements of more than one sub-element, class notations of all of these sub-elements the technical requirements of which the ship fulfilled may be added in the suffix of the class notation of environmental protection. Examples are given in Table 1.5.1.4 below:

**Examples of Assignment of Class Notation of Environmental Protection for
a Sea-going Ship Engaged on International Voyages** **Table 1.5.1.4**

	Class notation of environmental protection	Class notation of a corresponding sub-element “X”
Sea-going ships engaged on international voyages	G-EP (OIL2)	OIL2
	G-EP (OIL2, EAL, SC, SEC)	OIL2, EAL, SC, SEC
	G-EP (OIL2, EAL, N2, SC, GWC, NEC1, SEC, VCS, RSC2, GPR(EU))	OIL2, EAL, N2, SC, GWC, NEC1, SEC, VCS, RSC2, GPR(EU)

1.5.1.5 When a sea-going ship engaged on domestic voyages complies with the applicable requirements of regulation 4.2 and/or regulation 4.3 of Chapter 4 of the Rules, the class notation of ecological protection (Gd-ECO(X)) may be assigned. Where “X” represents the class notation of a corresponding sub-element specified in regulations 4.2 and 4.3 of Chapter 4 of the Rules. If the ship satisfies the technical requirements of more than one sub-element, class notations of all of these sub-elements the technical requirements of which the ship fulfilled may be added in the suffix of the class notation of ecological protection. Examples are given in Table 1.5.1.5 below:

**Examples of Assignment of Class Notation of Ecological Protection for
a Sea-going Ship Engaged on Domestic Voyages** **Table 1.5.1.5**

	Class notation of ecological protection	Class notation of a corresponding sub-element “X”
Sea-going ships engaged on domestic voyages	Gd-ECO (CD20)	CD20
	Gd-ECO (CD20, VIB3, NOI2)	CD20, VIB3, NOI2
	Gd-ECO (CD20, COM, VIB3, NOI2, CL1, UW, RN)	CD20, COM, VIB3, NOI2, CL1, UW, RN

1.5.1.6 When a sea-going ship engaged on domestic voyages complies with, in addition to the requirements of regulation 5.2 of Chapter 5 of the Rules, the applicable requirements of regulations 5.3 to 5.5 of Chapter 5 of the Rules, the class notation of environmental protection (Gd-EP(X)) may be assigned. Where “X” represents the class notation of a corresponding sub-element specified in regulations 5.3 to 5.5 of Chapter 5 of the Rules. If the ship satisfies the technical requirements of more than one sub-element, class notations of all of these sub-elements the technical requirements of which the ship fulfilled may be added in the suffix of the class notation of environmental protection. Examples are given in Table 1.5.1.6 below:

**Examples of Assignment of Class Notation of Environmental Protection for
a Sea-going Ship Engaged on Domestic Voyages** **Table 1.5.1.6**

	Class notation of environmental protection	Class notation of a corresponding sub-element “X”
Sea-going ships engaged on domestic voyages	Gd-EP (OIL2)	OIL2
	Gd-EP (OIL2, EAL, SC, SEC)	OIL2, EAL, SC, SEC
	Gd-EP (OIL2, EAL, SC, GWC, GBEC, SEC, VCS, RSC2)	OIL2, EAL, SC, GWC, GBEC, SEC, VCS, RSC2

1.5.2 Assignment of class notations for green eco-technology

1.5.2.1 A green eco-technology class notation and a green eco-ship class notation are independent from each other. If a ship to which a certain green eco-technology has been applied satisfies the requirements of a green eco-technology class notation for this green eco-technology, and also satisfies the requirements of a certain green eco-ship class notation, then the green eco-technology class notation and the green eco-ship class notation may be assigned at the same time. An example is given in Table 1.5.2.1 below:

Examples of Assignment of Ship Class Notations **Table 1.5.2.1**

	Class notation of environmental protection	Class notation of ecological protection	Class notation of green eco-technology	Assignment of ship class notations
Sea-going ships engaged on international voyages	G-EP (OIL2, EAL, SC, SEC)	G-ECO (CD26, COM, BWM(T))	AMPS, DFD	G-EP (OIL2, EAL, SC, SEC), G-ECO (CD26, COM, BWM(T)), AMPS, DFD
Sea-going ships engaged on domestic voyages	Gd-EP (OIL1, IBTS, SC, VCS)	Gd-ECO (CD20, VIB3, NOI2)	AMPS, LSDF	Gd-EP (OIL1, IBTS, SC, VCS), Gd-ECO (CD20, VIB3, NOI2), AMPS, LSDF

1.5.3 Sequence of green ecology class notations and characters of classification

1.5.3.1 The sequence of the assignment of green eco-ship class notations and green eco-technology class notations is to be arranged in accordance with Appendix 1 on the sequence of class notations of sea-going ships of Chapter 2 of PART ONE of CCS Rules for Sea-going Steel Ships.

1.5.4 Assignment, maintenance, suspension, cancellation and reinstatement of green eco-ship class notations

1.5.4.1 Assignment, maintenance, suspension, cancellation and reinstatement of green eco-ship class notations and green eco-technology class notations are to comply with the applicable requirements of Section 9, Chapter 2, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

1.6 Documentation requirements

1.6.1 In order to obtain the green eco-ship class notations, the relevant plans and documents as specified in the Rules are to be submitted for approval or for information. For easy retrieval, paragraphs of relevant documents with which the green eco-ship class notations of sea-going ships engaged on international voyages and domestic voyages as specified in the Rules are to comply are listed in Table 1.6.1(1) and Table 1.6.1(2) respectively.

Requirements for Plans and Documents
(for sea-going ships engaged on international voyages) **Table 1.6.1(1)**

Green elements	Applicable paragraphs	Green Eco-ship notations			
		G-EP	G-EP (X)	G-ECO	G-ECO (X)
Basic statutory requirements	2.2.2, 3.2.2	✓	✓	✓	✓
GHG emission control	2.3.4				✓
Prevention of transfer of invasive organism	2.4.3				✓
Environmental friendliness	2.5.6				✓
Control of discharge of water pollutants	3.3.6		✓		
Control of emission of air pollutants	3.4.7		✓		
Control of use of harmful material	3.5.3		✓		

Requirements for Plans and Documents
(for sea-going ships engaged on domestic voyages) **Table 1.6.1 (2)**

Green elements	Applicable paragraphs	Green Eco-ship notations		
		Gd-EP	Gd-EP (X)	Gd-ECO (X)
Basic statutory requirements	5.2.2	✓	✓	✓
GHG emission control	4.2.4			✓
Environmental friendliness	4.3.6			✓
Control of discharge of water pollutants	5.3.6		✓	
Control of emission of air pollutants	5.4.6		✓	
Control of use of harmful material	5.5.3		✓	

1.6.2 If any change, revision or deletion is made to the approved procedures, plans and documents as specified in relevant chapters of the Rules, the relevant details are to be re-submitted for approval.

1.7 Alteration and repair

1.7.1 A ship already having a CCS green eco-ship class notation and/or a green eco-technology class notation, which has undergone any alteration or repair of its construction, equipment, arrangement, procedures or plans, etc., in association with green elements, is to be subject to a survey, as appropriate, for confirming compliance with the technical requirements for the existing notations or the applied altered notations. In the case of a major conversion, attention is to be given to the relevant requirements of the flag State Administration.

Part I REQUIREMENTS FOR SEA-GOING SHIPS ENGAGED ON INTERNATIONAL VOYAGES

CHAPTER 2 REQUIREMENTS FOR ECOLOGICAL PROTECTION

2.1 General Requirements

2.1.1 This Chapter specifies the relevant requirements of the ecological protection notation G-ECO for sea-going ships engaged on international voyages.

2.1.2 Ecological protection elements for green eco-ships include the following three aspects:

- (1) GHG emission control: including the requirements for CO₂ emission design index and CO₂ emission operation management.
- (2) Prevention of transfer of invasive organism: including the requirements for ballast water and sediment management and bio-fouling management.
- (3) Environmental friendliness: including the requirements for comfort onboard (vibration, compartment noise, indoor climate), control of underwater noise and ambient noise.

2.1.3 Class notations related to ecological protection of green eco-ships are as follows:

- (1) Class notations of ecological protection for green eco-ships include:

G-ECO: means that only the mandatory and statutory requirements of international Conventions and Codes, etc. are complied with.

G-ECO(X): means that the requirements of some sub-elements of ecological protection are higher than those of international Conventions. Where X represents the class notation of a corresponding sub-element of ecological protection.

- (2) Class notations of GHG emission control include:

CD_x: means class notation of CO₂ emission design index, where “x” represents the percentage ratio of the ship’s Attained EEDI value lower than the reference line value for that ship.

COM: means class notation of CO₂ emission operation management, indicating the levels of ship energy efficiency management and company energy efficiency management.

- (3) Class notations of prevention of transfer of invasive organism include:

BWM(T, Ex, O): class notations of ballast water management, where:

BWM (T): means that ballast water is treated with a type approved BWMS to comply with D-2 standard;

BWM (Ex): means that ballast water exchange method is used, where “x” represents a specific exchange method, as below:

BWM(Es): means that sequential method is used;

BWM(Ef): means that flow-through method is used;

BWM (Ed): means that dilution method is used.

BWM(O): means that a ballast water management method other than the above is applied, e.g., discharge at the same location, non-carriage of ballast, other approved methods, etc.

When a ship satisfies two different ballast water exchange methods, the class notations of these two different ballast water exchange methods may be assigned, e.g. BWM(Ef, Es). However, the class notations of BWM (T), BWM (Ex) and BWM (O) cannot be assigned simultaneously.

BIO: means class notation of biofouling management, indicating that the ship has adopted technical and operational measures to control and manage biofouling to prevent transfer of invasive organism.

(4) Class notations of environmental friendliness include:

VIBx: means class notation of comfort onboard (vibration), where “x” represents the grade of comfort onboard (vibration);

NOIx: means class notation of comfort onboard (compartment noise), where “x” represents the grade of comfort onboard (compartment noise);

CLx: means class notation of comfort onboard (indoor climate), where “x” represents the grade of comfort onboard (indoor climate);

UW: means class notation of underwater noise, indicating the level of control of the adverse effects of underwater noise caused by the ship on aquatic life;

RN: means class notation of ambient noise, indicating the level of control of the adverse effects of noise caused by the ship on living and working environment of residents on shore.

2.2 Technical requirements for G-ECO class notation

2.2.1 General requirements

2.2.1.1 The “G-ECO” notation may be assigned to ships complying with the latest applicable requirements in force of the following Conventions and Codes and are provided with corresponding statutory certificates or documents of compliance:

- (1) Requirements of regulations on ship energy efficiency in MARPOL Annex VI;
- (2) International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004 (abbreviated as BWM convention) and its associated Guidelines;
- (3) Compartment noise onboard is to comply with IMO Code on Noise Levels on board Ships (MSC.337(91));
- (4) Ship ballast water management system (BWMS) is to comply with the requirements of IMO Guidelines for Approval of Ballast Water Management Systems (G8) (MEPC.174(58)) or the 2016 Guidelines for Approval of Ballast Water Management Systems (G8) (MEPC.279(70)) or the Code for Approval of Ballast Water Management Systems (MEPC.300(72)), and provided with valid type approval certificates.

2.2.2 Documentation requirements

2.2.2.1 The following documented applicable operational procedures are to be approved and kept onboard:

- (1) Ship energy efficiency management plan (SEEMP);
- (2) Ship ballast water management plan (BWMP).

2.2.2.2 The following applicable plans and documents are to be submitted for approval or for information:

(1) GHG emission control

- ① Technical file of EEDI that contains the information for calculation process and results of the Attained EEDI of ships, or similar documents;
- ② Relevant supportive background documents needed for verification of EEDI calculation and additional information necessary for the verification (for information);
- ③ Tank test plan or program, or description of exemption of tank test and supportive documents (for information);
- ④ Information on major conversion and description of recalculation of EEDI and technical file of the recalculated EEDI;
- ⑤ Other relevant plans and documents required by CCS Guidelines on Survey and Certification of the Energy Efficiency Design Index (EEDI) for ships (for information) .

(2) Ballast water management

- ① Arrangement of ballast water system, including details of ballast water processing;
- ② Arrangement of ballast water management system;
- ③ Arrangement of ventilation for the space where the BWMS is located;
- ④ Other relevant plans and documents required by 2.2 of CCS Guidelines on Survey and Certification for Ballast Water Management of Ships;

(3) Any information related to additional environmental protection requirements of ships raised by flag State Administration or the ship owner.

2.3 GHG emission control

2.3.1 Definitions and application

2.3.1.1 For the purpose of this regulation, the following definitions apply:

(1) *Bulk carrier* means a ship which is intended primarily to carry dry cargo in bulk, including ore carriers, as defined in SOLAS chapter XII, regulation 1, but excluding combination carriers. For ships dedicated to carrying cement, woodchips, fly ash and sugar, they are of the ship type of bulk carrier.

(2) *Gas carrier* means a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas, but excluding LNG carriers.

(3) *Tanker* means an oil tanker as defined in MARPOL Annex I, regulation 1 or a chemical tanker or an NLS (noxious liquid substance) tanker as defined in MARPOL Annex II, regulation 1.

(4) *Container ship* means a ship designed exclusively for the carriage of containers in holds and on deck.

(5) *General cargo ship* means a ship with a multi-deck or single deck hull designed primarily for the carriage of general dry cargo. This definition excludes specialized dry cargo ships, which are not included in the calculation of reference lines for general cargo ships, namely livestock carriers, barge carriers, heavy load carriers, yacht carriers and nuclear fuel carriers.

(6) *Refrigerated cargo carrier* means a ship designed exclusively for the carriage of refrigerated cargoes in cargo spaces.

(7) *Combination carrier* means a ship designed to load 100% deadweight with both liquid and dry cargo (including ores) in bulk.

(8) *Passenger ship* means a ship which carries more than 12 passengers.

(9) *Ro-ro passenger ship* means a passenger ship with roll-on-roll-off cargo spaces.

(10) *Ro-ro cargo ship (vehicle carrier)* means a multi-deck roll-on-roll-off cargo ship designed for the carriage of empty cars and trucks.

(11) *Ro-ro cargo ship* means a ship designed for the carriage of roll-on-roll-off cargo transportation units.

(12) *LNG carrier* means a cargo ship constructed or adapted and used for the carriage in bulk of liquefied natural gas (LNG).

(13) *Cruise passenger ship* means a passenger ship not having a cargo deck, designed exclusively for commercial transportation of passengers in overnight accommodations on a sea voyage.

(14) *Category A ship* means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions, as defined in the Polar Code.

(15) *Conventional propulsion* means a method of propulsion where a main reciprocating internal combustion engine(s) is the prime mover and coupled to a propulsion shaft either directly or through a gear box.

(16) *Non-conventional propulsion* means a method of propulsion, other than conventional propulsion, including diesel-electric propulsion, turbine propulsion, and hybrid propulsion systems.

2.3.1.2 Regulation 2.3.2 does not in principle apply to ships which have non-conventional propulsion as defined in 2.3.1.1 (1) to 2.3.1.1 (11) above.

2.3.1.3 For the purpose of cruise passenger ships as defined in 2.3.1.1 (13) above, regulation 2.3.2 only applies to cruise passenger ships having non-conventional propulsion systems.

2.3.1.4 Regulation 2.3.2 does not apply to passenger ships and category A ships as defined in 2.3.1.1 (8) and 2.3.1.1 (14) above.

2.3.1.5 Regulation 2.3.2 does not apply to ships other than those defined in 2.3.1.1(1) to 2.3.1.1 (7), and 2.3.1.1 (9) to 2.3.1.1 (13) above.

2.3.1.6 Regulation does not apply to ships not propelled by mechanical means such as barges, and platforms (including FPSOs and FSUs) and drilling units.

2.3.2 Requirements for CO₂ emission design index for ships

2.3.2.1 For the purpose of CO₂ emission design index for ships, the Attained EEDI and Required EEDI are defined as follows:

(1) Attained EEDI means the EEDI value actually achieved by an individual ship.

(2) Required EEDI means the maximum value of the Attained EEDI permissible for the specific ship type and size as specified in Regulation 21, Chapter 4 of MARPOL Annex VI.

2.3.2.2 The value of the Attained EEDI of a ship is to be less than or equal to the Required EEDI value corresponding to this ship:

$$\text{Attained EEDI} \leq \text{Required EEDI} = (1 - X/100) \times RLV$$

Where: *RLV* – EEDI reference line value of the ship (referred to as RLV);

X – reduction factor for determination of the Required EEDI for an individual ship (See Table 2.3.2.4).

2.3.2.3 The Reference line value (*RLV*) of a ship is to be determined by the following formula and the relevant parameters given in Table 2.3.2.3:

$$RLV = a \times b^{(-c)}$$

Parameters for determination of Reference Line Value (*RLV*) **Table 2.3.2.3**

Ship type	<i>a</i>	Capacity <i>b</i>	<i>c</i>
Bulk carrier	961.79	DWT (DWT ≤ 279000) ; 279000 (DWT > 279000)	0.477
Gas carrier	1120.00	DWT	0.456
Tanker	1218.80	DWT	0.488
Container ship	174.22	DWT	0.201
General cargo ship	107.48	DWT	0.216
Refrigerated cargo carrier	227.01	DWT	0.244
Combination carrier	1219.00	DWT	0.488
Ro-ro passenger ship	902.59	DWT (DWT ≤ 10000) ; 10000 (DWT > 10000)	0.381
Ro-ro cargo ship (vehicle carrier)	(DWT/GT) ^{-0.7} ·780.36, where (DWT/GT) < 0.3; 1812.63, where (DWT/GT) ≥ 0.3	DWT	0.471
Ro-ro cargo ship	1686.17	DWT (DWT ≤ 17000) ; 17000 (DWT > 17000)	0.498
LNG carrier	2253.7	DWT	0.474
Cruise passenger ship having non-conventional propulsion system	170.84	GT	0.214

2.3.2.4 The reduction factor of the Required EEDI for an individual ship is to comply with the corresponding requirements in Chapter 4 of MARPOL ANNEX VI, as shown in Table 2.3.2.4.

Reduction Factors for Calculation of Required EEDI **Table 2.3.2.4**

Ship type	Size	Reduction factor X			
		Phase 1	Phase 2	Phase 3	
		2015.01.01 ~ 2019.12.31	2020.01.01 ~ 2024.12.31	2022.01.01 and onwards	2025.01.01 and onwards
Bulk carrier	≥ 20000 DWT	10	20		30
	20000 > DWT ≥ 10000	0 ~ 10*	0 ~ 20*		0 ~ 30*
Gas carrier	≥ 15000 DWT	10	20	30	
	15000 > DWT ≥ 10000	10	20		30
	10000 > DWT ≥ 2000	0 ~ 10*	0 ~ 20*		0 ~ 30*
Tanker	≥ 20000 DWT	10	20		30
	20000 > DWT ≥ 4000	0 ~ 10*	0 ~ 20*		0 ~ 30*

Ship type	Size	Reduction factor X			
		Phase 1	Phase 2	Phase 3	
		2015.01.01~2019.12.31	2020.01.01~2024.12.31	2022.01.01 and onwards	2025.01.01 and onwards
Container ship	≥200000DWT	10	20	50	
	200000>DWT≥120000	10	20	45	
	120000>DWT≥80000	10	20	40	
	80000>DWT≥40000	10	20	35	
	40000>DWT≥15000	10	20	30	
	15000>DWT≥10000	0~10*	0~20*	15~30*	
General cargo ship	≥15000DWT	10	15	30	
	15000>DWT≥3000	0~10*	0~15*	0~30*	
Refrigerated cargo carrier	≥5000DWT	10	15		30
	5000>DWT≥3000	0~10*	0~15*		0~30*
Combination carrier	≥20000DWT	10	20		30
	20000>DWT≥4000	0~10*	0~20*		0~30*
Ro-ro passenger ship	≥1000DWT	5	20		30
	1000>DWT≥250	0~5*	0~20*		0~30*
Ro-ro cargo ship (Vehicle carrier)	≥10000DWT	5	15		30
Ro-ro cargo ship	≥2000DWT	5	20		30
	2000>DWT≥1000	0~5*	0~20*		0~30*
LNG carrier	≥10000DWT	10	20	30	
Cruise passenger ship having non-conventional propulsion system	≥85000GT	5	20	30	
	85000>GT≥25000	0~5*	0~20*	0~30*	

* Reduction factor to be linearly interpolated between the two values dependent upon ship size.

2.3.2.5 The class notation of CO₂ emission design index (CD_x) may be assigned to a ship having the Attained EEDI less than or equals to the Required EEDI, of which x is to be calculated using the following formula:

$$x\% = \frac{RLV - \text{Attained EEDI}}{RLV} \times 100\%$$

Where x takes only the integer by rounding off the decimal part.

2.3.2.6 If the design of a ship falls into more than one of the above ship types, the Required EEDI of the ship is to be the lowest Required EEDI.

2.3.2.7 The Attained EEDI is to be calculated in accordance with Appendix 1-1 of the Rules.

2.3.2.8 The Attained EEDI is to be verified in accordance with CCS Guidelines on Survey and Verification of the Energy Efficiency Design Index (EEDI) of Ships.

2.3.2.9 The installed propulsion power of the ship is not to be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions. For bulk carriers, tankers and combination carriers, the installed propulsion power of the ship is to be determined in accordance with Appendix 3 of the Rules.

2.3.3 Requirements for CO₂ emission operation management of ships

2.3.3.1 The COM notation may be assigned to ships complying with the following requirements:

(1) The ship is to hold an SEEMP developed in accordance with the IMO 2016 Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP) (MEPC.282(70), as amended) and approved by CCS;

(2) The ship is to hold a Ship Energy Efficiency Management Certificate (SEEMC) issued in accordance with CCS Rules for Certification of Ship Energy Efficiency Management.

(3) The ship management company is to establish a management system for ship operational energy efficiency, according to the requirements of CCS Rules for Certification of Ship Energy Efficiency Management, and to hold a Company Energy Efficiency Management Certificate (CEEMC) issued according to the above rules.

(4) The ship is to have management measures capable of increasing ship energy efficiency, e.g. route/speed optimization, trim optimization, and hull bio-fouling monitoring and management, etc., carry out real time or regular monitoring and evaluation, and make adjustment according to the implementation results.

2.3.4 Documentation Requirements

2.3.4.1 For ships to be assigned with notations for GHG emission control, the following documents are to be submitted for approval or for information:

(1) Technical file of EEDI and calculation process and results of the Attained EEDI value of ships, or similar documents;

(2) Relevant supportive background documents needed for EEDI calculation and verification as well as additional information necessary for verification (for information);

(3) Tank test plan or program (for information);

(4) Description of exemption of tank test and supportive documents (for information);

(5) Information on major conversion and description of recalculation of EEDI and technical file of the recalculated EEDI;

(6) Ship energy efficiency management plan (SEEMP).

2.4 Prevention of transfer of invasive organisms

2.4.1 Ship ballast water management

2.4.1.1 Ships in compliance with the following requirements may be assigned with class notations of ballast water management as follows:

(1) The BWM (T) notation maybe assigned to a ship which has been installed with a BWMS as described in 2.2.1.1(4) to comply with the D-2 standard specified in the BWM Convention;

(2) When a ballast water exchange method has been adopted onboard the ship to comply with the applicable requirements of the BWM Convention, the following notations of ballast water exchange maybe assigned:

BWM(Es): when the sequential method is used;

BWM(Ef): when the flow-through method is used;

BWM (Ed): when the dilution method is used.

(3) The BWM(O) notation may be assigned to a ship where other ballast water management methods are adopted onboard the ship (e.g., discharge of ballast water at the same location, drinking water used as ballast water, non-carriage of ballast, etc.) to comply with the applicable requirements of the BWM Convention.

2.4.1.2 When any ballast water exchange method is adopted onboard a ship, safety assessment is to be carried out in accordance with CCS Guidelines for Development of Ship's Ballast Water Management Plan.

2.4.1.3 The ballast water management systems are to be installed onboard ships in compliance with the applicable requirements of Additional Requirements for Installation of Ballast Water Management Systems in Chapter 26 of PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships.

2.4.2 Control of ships' biofouling

2.4.2.1 The BIO notation may be assigned to a ship complying with the requirements of 2.4.2.2 to 2.4.2.7 below:

2.4.2.2 A biofouling management plan is to be kept onboard. This plan is to be developed according to the 2011 Guidelines for the Control and Management of ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species approved by Resolution MEPC.207(62), and is to be approved by CCS.

2.4.2.3 A Biofouling Record Book in accordance with Appendix 2 of Resolution MEPC.207(62) is also to be kept onboard the ship.

2.4.2.4 Suitable anti-fouling systems are to be applied to the ships' submerged surfaces including the hull and niche areas. An anti-fouling system can be a coating system applied to exposed surfaces, biofouling resistant materials used for piping and other unpainted components, marine growth prevention systems (MGPSs) for sea chests and internal seawater cooling systems, or other innovative measures to control biofouling.

2.4.2.5 Anti-fouling systems used onboard ships are to be in compliance with the requirements of AFS Convention.

2.4.2.6 At least the following factors are to be considered when choosing an anti-fouling system:

- (1) planned periods between dry-docking: including any mandatory requirements for ships survey;
- (2) ship speed: different anti-fouling systems are designed to optimize anti-fouling performance for specific ship speeds;
- (3) operating profile: patterns of use, trade routes and activity levels, including periods of inactivity, influence the rate of biofouling accumulation;
- (4) ship type and construction;
- (5) differential needs of different areas of the ship for anti-fouling systems and facilitation of installation and repair.

2.4.2.7 The ship is to monitor the state of anti-fouling system and forming of biofouling on a regular basis according to the biofouling management plan and regular cleaning is to be performed.

2.4.3 Documentation requirements

2.4.3.1 For a ship to be assigned with the notations of prevention of transfer of invasive organisms, the following applicable documents are to be submitted for approval:

- (1) Ship ballast water management plan (BWMP);
- (2) Ship biofouling management plan;
- (3) Plans and documents as listed in 2.2.2.2(2) of the Rules.

2.5 Environmental friendliness

2.5.1 Vibration

2.5.1.1 For the purpose of this regulation, the following definitions apply:

- (1) *Passenger spaces* mean all areas intended for passenger use, and include passenger cabins, public spaces (e.g. restaurants, hospital, gymnasiums, shops, open deck recreation areas, etc.).
- (2) *Crew spaces* means all areas intended for crew use only, and include crew cabins, public spaces (e.g. mess rooms, conference rooms, offices, etc.), and work areas (e.g. wheelhouse, engine control room and workshops, etc.).
- (3) *Vibration level* means the overall frequency weighted r.m.s. value of vibration over the frequency range 1 to 80 Hz.

2.5.1.2 The VIBx notation may be assigned to ships complying with the relevant requirements of 2.5.1.3 upon measurement, wherex represents the comfort grades 1, 2, 3, where “1” means an acceptable grade and “3” means the highest grade.

2.5.1.3 Technical requirements for assignment of the class notation of comfort onboard (vibration) are as follows:

- (1) Vibration measurements are to be carried out in accordance with the requirements of Section 4 of Chapter 16 of PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships.
- (2) If, for all the compartments or spaces, vibration levels are lower than or equal to those corresponding to a given comfort grade, then the granted grade is that grade.
- (3) Measured vibration levels slightly greater than those specified in the comfort criteria may be accepted. Not more than 20 percent of measuring points may exceed the relevant vibration criteria by 0.3 mm/s.
- (4) The maximum allowable vibration levels for passenger spaces are given in Table 2.5.1.3(1).

Passenger Spaces – Maximum Allowable Vibration Levels in mm/s Table 2.5.1.3(1)

Location	Comfort grade (vibration)(x)		
	1	2	3
Passenger cabins, superior	2.2	2.0	1.7
Passenger cabins, standard	3.0	2.5	2.0
Passenger public spaces	4.0	3.5	3.0
Open deck recreation areas	4.0	3.5	3.0

- (5) The maximum allowable vibration levels for crew spaces are given in Table 2.5.1.3(2).

Crew Spaces – Maximum Allowable Vibration Levels in mm/s Table 2.5.1.3(2)

Location	Comfort grade (vibration) (x)		
	1	2	3
Crew cabins	3.2	3.0	2.8
Wheel house, radio room	4.0	3.5	3.0
Crew public spaces, mess rooms	4.0	3.5	3.0
Hospital	3.2	3.0	2.8
Offices	4.0	3.5	3.0
Workshops	6.5	6.0	5.0
Engine control room	6.0	5.0	4.0

2.5.2 Compartment noise

2.5.2.1 For the purpose of this regulation, the following definition applies:

(1) Noise level means the A-weighted equivalent continuous sound pressure level measured in accordance with ISO 2923(1996).

2.5.2.2 The NOIx notation may be assigned to ships complying with the relevant requirements of 2.5.2.3 upon measurement, where x represents the comfort grades 1, 2, 3, where 1 means an acceptable grade and 3 means the highest grade .

2.5.2.3 Technical requirements for assignment of the class notation of comfort onboard (noise) are as follows:

(1) Noise measurements are to be carried out in accordance with the requirements of CCS Guidelines for Control and Measurement of Noises for Ships and Marine Products.

(2) If, for all the compartments or spaces, noise levels are lower than or equal to those corresponding to a given comfort grade, then the granted grade is that grade.

(3) Measured noise levels slightly greater than those specified in the comfort criteria may be accepted. Not more than 20 percent of the passenger cabins, 30 percent of the public spaces and 20 percent of the crew cabins are to exceed the relevant noise criteria by 3 dB(A).

(4) For passenger ships, the maximum allowable noise levels of passenger spaces for different ship types, locations and comfort grades are given in Table 2.5.2.3(1).

Passenger Ships – Maximum Allowable Noise Levels in dB(A) of Passenger Spaces Table 2.5.2.3(1)

Location	Comfort grade (noise)(x)		
	1	2	3
Passenger cabins, superior	50	47	45
Passenger cabins, standard	55	52	49
Passenger public spaces	62	58	55
Hospital	55	52	49
Theatre	60	55	53
Open deck recreation areas ^{①②③}	73	69	65

Notes: ① The levels may be exceeded by 5 dB(A) in sports areas.

② The levels may be exceeded by 5 dB(A) within 3 m of a ventilation inlet/outlet.

③ The levels for open deck recreation areas refer to ship generated noise only, and the noise generated from the effects of wind and waves are not considered.

(5) The bulkhead and deck air-borne sound insulation indices for passenger spaces, R_w , calculated in accordance with ISO R717/1, are to be in compliance with Table 2.5.2.3(2).

Passenger ships – Minimum Airborne Sound Insulation Indices, R_w Table 2.5.2.3(2)

Location	Comfort grade (noise) (x)		
	1	2	3
Passenger cabins, superior	40	42	45
Passenger cabins, standard	36	38	40
Superior passenger cabin to corridor	37	40	42
Standard passenger cabin to corridor	34	36	38
Superior passenger cabin to stairwell	45	47	50
Standard passenger cabin to stairwell	43	45	47
Superior passenger cabin to passenger/crew public space	50	50	55
Standard passenger cabin to passenger/crew public space	48	48	52
Passenger cabins to discotheques	60	60	60
Passenger cabins to machinery spaces	50	53	55
Discotheques to stairwells and passenger/crew public spaces	52	52	52

Note: Not more than 20 percent of the interfaces tested of bulkheads and decks may have airborne sound insulation indices 3 dB(A) lower than the minimum specified values in Table 2.5.2.3(2).

(6) The maximum allowable noise levels and the comfort grades for crew cabins and public spaces are given in Table 2.5.2.3(3).

Crew Cabins and Public Spaces – Maximum Allowable Noise Levels in dB(A) Table 2.5.2.3(3)

Location	Comfort grade (noise) (x)		
	1	2	3
Sleeping cabins	55	52	49
Hospital	55	52	49
Conference rooms, offices, mess rooms	60	57	55
Crew public spaces	65	60	57
Galleys, changing rooms, laundries, bathrooms	75	73	70
Open deck recreation areas ^①	75	73	70

Note: ① The levels may be exceeded by 5 dB(A) within 3 m of a ventilation inlet/outlet.

(7) The maximum allowable noise levels and the comfort grades for crew work areas are given in Table 2.5.2.3(4).

Crew Work Areas – Maximum Allowable Noise Levels in dB(A) Table 2.5.2.3(4)

Location	Comfort grade (noise) (x)		
	1	2	3
Engine control room	75	73	70
Wheelhouse	65	63	60
Radio room	60	57	55
Workshops	85	85	85
Machinery spaces	110	110	110

(8) The bulkhead and deck air-borne sound insulation indices for crew spaces, R_w , calculated in accordance with ISO R717/1, are to be in compliance with Table 2.5.2.3(5).

Crew Spaces – Minimum Airborne Sound Insulation Indices, R_w Table 2.5.2.3(5)

Location	Comfort grade (noise)(x)		
	1	2	3
Crew cabins	35	38	40
Crew cabin to corridor	30	32	35
Crew cabin to stairwell	30	32	35
Crew cabin to passenger/crew public spaces	45	45	45

Note: Not more than 20 percent of the interfaces tested of bulkheads and decks may have airborne sound insulation indices 3 dB(A) lower than the minimum specified values in Table 2.5.2.3(5).

2.5.3 Indoor climate

2.5.3.1 The requirements of this regulation apply to indoor environmental control of passenger ships.

2.5.3.2 For the purpose of this regulation, the following definitions apply:

(1) *Indoor climate* means air temperature, relative humidity, air velocity and temperature change used as descriptors for indoor climate.

(2) *Air velocity* means the measured mean velocity of a mass of air in motion.

(3) *Outside air temperature* means the actual air temperature measured out of direct sun exposure outside of the ship.

(4) *Fresh air supply quantity* means the quantity of fresh outside air per person supplied to a designated space.

(5) *Relative humidity* means the ratio between the actual amount of water vapour in the air and the saturation amount of water vapour in the air, expressed as percentage.

(6) *Temperature* means the average temperature of a specific number of temperature measurements in a particular space.

(7) *Density of population* means the number of people on per square meter area of a space.

2.5.3.3 The CL_x notation may be assigned to ships complying with the relevant requirements of 2.5.3.4 to 2.5.3.8 upon measurement, where indoor temperature, relative humidity, air velocity and fresh air supply are all at least to satisfy the corresponding requirements for a certain grade of x. x represents the comfort grades 1, 2, 3, where 1 means an acceptable grade and 3 means the highest grade.

2.5.3.4 Indoor temperature

Corresponding to different grades of comfort class notations, requirements for indoor temperature at different locations are shown in Table 2.5.3.4. Meanwhile the following requirements are to be complied with:

(1) Corresponding to different comfort grades of CL_x, each designated cabin/space is to be able to reduce by 3°C from the highest heating temperature limit in winter or increase by 3°C from the lowest cooling temperature limit in summer in not more than 2 hours, 1.5 hours and 1 hours respectively.

(2) For comfort notations CL₁ and CL₂, individual temperature control of the designated space/cabin is to be provided.

(3) For comfort notation CL₃, individual and automatic temperature control (with thermostat) of the designated space/cabin is to be provided.

Indoor Temperature Required at Different Locations **Table 2.5.3.4**

Location	Outdoor temperature	Indoor temperature(°C)/grade (x)		
		1	2	3
Areas for long-term stay (e.g. living areas such as passenger cabins, etc.), hospital	15°C and below	20	22	24
	40°C and below	26	25	24
Areas for short-term stay (public spaces such as conference rooms, libraries, card rooms, seating areas, dining areas, casinos, shopping areas, bars, dance lounges, discos, gymnasiums)	15°C and below	19	21	23
	40°C and below	27	26	25

Notes: ① For outside temperatures between 15°C and 40°C, the required indoor temperature value is to be obtained through linear interpolation.

② For areas with special requirements, the temperature control criteria may be considered separately.

2.5.3.5 Relative humidity

Corresponding to different grades of the comfort class notation (indoor climate) CLx, requirements for relative humidity at different locations are shown in Table 2.5.3.5.

Relative Humidity Required at Different Locations **Table 2.5.3.5**

Location	Relative humidity(%) /grade(x)		
	1	2	3
Passenger cabins, hospital, public spaces intended for low physical activity (such as conference rooms, libraries, card rooms, seating areas), public spaces intended for high physical activity (such as show lounges, dining areas, casinos, shopping areas, bars, dance lounges, discos, gymnasiums)	< 65	20~60	30~60

2.5.3.6 Air Velocity

Corresponding to different grades of the comfort class notation (indoor climate) CLx, requirements for air velocity at different locations are shown in Table 2.5.3.6.

Maximum Air Velocity Required at Different Locations **Table 2.5.3.6**

Location	Maximum air velocity(m/s) /grade(x)		
	1	2	3
Passenger cabins	0.35	0.30	0.25
Hospital	0.25	0.2	0.15
Public spaces intended for low physical activity (such as conference rooms, libraries, card rooms, seating areas)	0.3	0.25	0.2
Public spaces intended for high physical activity (such as show lounges, dining areas, casinos, shopping areas, bars, dance lounges, discos, gymnasiums)	0.35	0.3	0.25

Notes: ① The maximum air velocity specified in the above table corresponds to outdoor temperatures of 40°C and above. Where outdoor temperatures are of 15°C and below, the maximum air velocity is to deduct 0.05m/s respectively from the values specified in Table 2.5.3.6.

② For outside temperatures between 15°C and 40°C, the required maximum air velocity value is to be obtained through linear interpolation.

2.5.3.7 Fresh air supply quantity

(1) Corresponding to different grades of the comfort class notation (indoor climate) CLx, requirements for minimum fresh air supply quantity per person at different locations are shown in Table 2.5.3.7 (1).

Minimum Fresh Air Supply Quantity Per Person Required at Different Locations Table 2.5.3.7 (1)

Location	Minimum fresh air supply quantity($\text{m}^3/(\text{h} \cdot \text{person})$)/grade (x)		
	1	2	3
Passenger cabins	30	30	35

Note: ① Unless otherwise specified by owner and yard the number of persons in each designated cabin/space will be counted according to ISO7547.

(2) The hospital onboard is to be provided with fresh air system, the design minimum fresh air supply quantity of which is to be determined by air changes, as shown in Table 2.5.3.7(2).

Minimum Air Changes Required in Hospital Table 2.5.3.7(2)

Location	Minimum air changes(h^{-1})/grade (x)		
	1	2	3
Hospital	2	2.5	3

(3) The design minimum fresh air supply quantity for spaces with high density of population is to be determined according to the minimum fresh air supply quantity per person required under different densities of population, as shown in Table 2.5.3.7 (3).

Minimum Fresh Air Supply Quantity per Person Required under Different Densities of Population Table 2.5.3.7 (3)

Location	Minimum fresh air supply quantity($\text{m}^3/(\text{h} \cdot \text{person})$)/grade(x)								
	1			2			3		
	PF $\leq$ 0.4	0.4<PF $\leq$ 1.0	PF>1.0	PF $\leq$ 0.4	0.4<PF $\leq$ 1.0	PF>1.0	PF $\leq$ 0.4	0.4<PF $\leq$ 1.0	PF>1.0
Public spaces intended for low physical activity (such as conference rooms, libraries, card rooms, seating areas)	13	10	9	17	11	10	26	18	16
Public spaces intended for high physical activity (such as show lounges, dining areas, casinos, shopping areas, bars, dance lounges, discos, gymnasiums)	17	15	14	25	18	15	40	37	36

Note: PF means density of population.

2.5.3.8 Indoor climate is to be measured according to the requirements described in Chapter 4 of Appendix 1 of CCS Rules for Cruise Ships.

2.5.4 Underwater noise

2.5.4.1 For the purpose of this regulation, the following definitions apply:

(1) *Sound source level L_{p1m}* means the sound pressure level at a distance of 1 m from the equivalent sound center obtained by conversion, in dB.

(2) *Ship acoustic center* means the position of the sound source for the postulated point. The acoustic center is taken longitudinally as the midpoint of the distance between the propeller and the main engine, and vertically at 2/3 of the draft below the waterline.

(3) *Closest point of approach (CPA)* means in the measurement of underwater radiated noise, the vertical foot obtained from the trajectory of hydrophone to ship acoustic center.

(4) *Distance at the closest point of approach* (d_{cpa}) means the horizontal distance from the closest point of approach to the hydrophone, in m.

(5) *Background noise* means the ambient noise in water received by the hydrophone, which is not affected by the ship noise under test.

(6) *Typical navigational condition* means navigational condition for common operation.

2.5.4.2 The UW notation may be assigned to ships complying with the requirements of 2.5.4.3 upon measurement.

2.5.4.3 Underwater radiated noise limits

(1) Underwater radiated noise is to be measured according to the requirements of CCS Guidelines for Underwater Radiated Noise of Ships.

(2) The one-third octave band frequency sound pressure level of underwater radiated noise of ships is to be measured and the sound source level at 1 m from the equivalent acoustic center is to be obtained by conversion.

(3) The side thruster condition is not considered as the assessment condition of underwater radiated noise.

(4) Measurement is to be conducted in typical navigational conditions and the result of measurement is to comply with the requirements of Table 2.5.4.3.

Underwater radiated noise limits(dB)

Table 2.5.4.3

Frequency range	Limit criteria dB (reference sound pressure 1μPa)
10 ~315Hz	168
315Hz~1 kHz	208~16 lgf(Hz)
1~100 kHz	160~12 lgf(kHz)

2.5.5 Ambient noise

2.5.5.1 For the purpose of this paragraph, the following definitions apply:

(1) *Maximum AS-weighted sound pressure level* means maximum sound pressure level achieved from measurement during the passage of the vessel or yacht under specified operating conditions measured with frequency weighting A and with time weighting S according to IEC 61672-1, expressed in decibels(dB).

(2) *Background noise* means noise from all sources other than the craft under test, e.g., noise from waves splashing on the measuring craft or the shore, other craft or equipment, and wind effects.

(3) *Day time equivalent sound level* means the maximum AS-weighted sound pressure level measured during the day time period, in dB.

(4) *Night time equivalent sound level* means the maximum AS-weighted sound pressure level measured during the night time period, in dB.

(5) *Day time* means the time period from 6:00 to 22:00.

(6) *Night time* means the time period from 22:00 to 6:00 of the next day.

(7) *Typical navigational condition* means the navigational condition for common operation.

2.5.5.2 The RN notation may be assigned to ships complying with the requirements of 2.5.5.3 upon measurement .

2.5.5.3 Limits of ambient noise

- (1) Ambient noise is to be measured according to the requirements described in Appendix 4 of the Guidelines.
- (2) Measurements are to be performed for ships in typical navigational condition and operating in harbours respectively, the results of which are to comply with the requirements in (3) below.
- (3) The maximum AS-weighted sound pressure levels for ships navigating in course and operating in harbors are to comply with the requirements in Table 2.5.5.3.

Limits of noise from ships navigating in course or operating in harbors (dB(AS)) Table 2.5.5.3

Ship type		Noise limit (dB)
Navigating in course		65
Operating in harbors	Day time	65
	Night time	60

2.5.6 Documentation requirements

2.5.6.1 For ships to be assigned with notations for environmental friendliness, the following applicable documents are to be submitted for approval or for information.

2.5.6.2 Documents for class notation of vibration are to include:

- (1) Measurement procedures, including arrangement of measuring points, loading conditions, machine operating conditions, weather conditions, measuring instruments, etc.;
- (2) Measurement reports, including vibration measurement results, etc.;
- (3) A general arrangement plan in which measuring points are indicated(for information).

2.5.6.3 Documents for class notation of noise are to include:

- (1) Measurement procedures, including arrangement of measuring points, loading conditions, machine operating conditions, weather conditions, measuring instruments, etc.;
- (2) Measurement reports, including noise measurement results, etc.;
- (3) A general arrangement plan in which measuring points are indicated (for information).

2.5.6.4 Documents for class notation of indoor climate are to include:

- (1) Measurement procedure, at least including ship information, HVAC system parameter and HVAC system arrangement, etc.;
- (2) Measurement report, to include measurement information, position of measuring points, measuring instruments, measurement results.

2.5.6.5 Documents for class notation of underwater noise are to include:

(1) Measurement program, including measuring instruments, measurement conditions, the operation status of the ship under test, measurement procedure, etc.;

(2) Measurement report, including differences with the measurement program, background noise spectrum, background noise correction method, result and criterion of one-third octave band frequency sound pressure level, etc.

2.5.6.6 Documents for class notation of ambient noise are to include:

(1) Measurement program, including measuring instrument, measurement conditions, measurement procedure, etc.;

(2) Measurement report, including background noise, background noise correction, result of ambient noise measurement, etc.

CHAPTER 3 REQUIREMENTS FOR ENVIRONMENTAL PROTECTION

3.1 General requirements

3.1.1 This Chapter specifies the relevant requirements of environmental protection elements for G-EP class notation for sea-going ships engaged on international voyages.

3.1.2 Environmental protection elements for green eco-ships include the following three aspects:

(1) control of discharge of water pollutants, including control of discharge into the sea of oil, noxious liquid substances, harmful substances carried by sea in packaged form, sewage and grey water and garbage;

(2) control of emission of air pollutants, including nitrogen oxides (NO_x) from marine engines, sulphur oxides (SO_x) and particulate matter (PM) and black carbon (BC) from fuel combustion, volatile organic compounds (VOCs) from cargoes, ozone-depleting substances (ODS) from ship's fire-extinguishing systems and refrigeration systems, exhaust gas from onboard incineration;

(3) control of use of hazardous materials, including prohibiting the use of hazardous materials such as harmful anti-fouling systems (AFS) and asbestos, control of use of other hazardous materials^①, prevention of pollution from recycling of ships.

3.1.3 Class notations related to environmental protection of green eco-ships are as follows:

(1) Class notations of environmental protection for green eco-ships include:

G-EP: means that only the mandatory and statutory requirements of international Conventions and Codes, etc. are complied with.

G-EP (X): means that the requirements of some sub-elements of environmental protection are higher than those of international Conventions. Where X represents the class notation of a corresponding sub-element of environmental protection.

(2) Class notations for control of discharge of water pollutants include the following:

OILx: means class notation for control of oil pollutants, where x represents the level of control of oil pollutants;

EAL: means that environmental acceptable lubricants are used or other equivalent measures are adopted on the ship;

IBTS: means that the ship satisfies the requirements for integrated bilge water treatment system;

NLSx: means class notation for control of noxious liquid substances, where x represents the level of control of noxious liquid substances;

SC: means class notation for control of discharge of sewage;

GWC: means class notation for control of discharge of grey water;

RC: means class notation for control of discharge of garbage.

^① Including 9 hazardous materials listed in Appendix 2 of the Hong Kong Convention.

(3) Class notations for control of emission of air pollutants include the following:

NECx: means class notation for control of NO_x emission from diesel engines, where x represents the level of emission control;

SEC: means class notation for emission control of SO_x and particulate matter (PM) from ships;

VCS: means class notation for VOC emission control of cargoes of tankers;

VCS-T: means class notation for VOC emission control of cargoes of auxiliary ships;

RSCx: means class notation for management and emission control of refrigerant of refrigeration system of ships, where x represents the level of emission control;

INC: means class notation for emission control of incineration operation on board;

BC20: means class notation for emission control of black carbon of marine diesel engines, where 20 represents reduction of black carbon emission by 20% and over;

BC70: means class notation for emission control of black carbon of marine diesel engines, where 70 represents reduction of black carbon emission by 70% and over;

(4) Class notation for the control of use of hazardous materials:

AFS: means class notation for anti-fouling systems that do not use organotin compounds as biocides;

AFS+: means class notation for anti-fouling systems that do not contain any biocides;

GPR/ GPR+: means class notation for control of hazardous materials of ships, indicating that the ship has inventory of hazardous materials complying with the requirements of the convention;

GPR (EU) /GPR (EU) +: means class notation for control of hazardous materials of ships, indicating that the ship has inventory of hazardous materials complying with the requirements of EU ship recycling regulation.

3.2 Technical requirements for G-EP class notation

3.2.1 General requirements

3.2.1.1 The G-EP notation may be assigned to ships complying with the latest requirements in force of the following conventions and codes, as applicable, and holding the corresponding statutory certificates or document of compliance:

(1) MARPOL Annexes I to VI, except for regulations on energy efficiency of ships in Annex VI;

(2) International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001 (referred to as the AFS Convention);

(3) marine diesel engines are to comply with IMO Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (MEPC.177(58)) and amendments related thereto;

(4) shipboard incinerators are to comply with IMO 2014 Standard Specification for Shipboard Incinerators (MEPC.244(66)) and amendments related thereto;

(5) exhaust gas cleaning systems of sulphur oxides are to comply with IMO 2015 Guidelines for Exhaust Gas Cleaning Systems (MEPC.259(68)) and amendments related thereto;

(6) oil filtering equipment of bilges is to comply with IMO Revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships (MEPC.107(49)) and amendments related thereto;

(7) sewage treatment plants are to comply with IMO 2012 Guidelines on implementation of effluent standards and performance tests for sewage treatment plants (MEPC.227(64)) and amendments related thereto.

3.2.1.2 In addition, ships to be assigned the G-EP notation are to comply with the following requirements, as applicable:

(1) For ships with an aggregate oil fuel capacity of 600 m³ and above, the design of all oil fuel tanks with individual capacity greater than 30 m³ is to comply with the requirements for oil fuel tank protection of regulation 12A of MARPOL Annex I.

(2) The use of ozone-depleting substances is prohibited in shipboard refrigerating systems (excluding permanently sealed equipment without refrigerant charging connection or permanently sealed equipment without removable parts containing ozone-depleting substances) and fire-extinguishing systems (including fixed fire-extinguishing systems and portable fire extinguishers).

3.2.2 Documentation requirements

3.2.2.1 The following operational procedural documents, where applicable, are to be approved and kept on board the ship:

(1) Shipboard oil pollution emergency plan;

(2) STS operations plan (only for oil tankers conducting STS operations);

(3) Garbage management plan;

(4) Fuel oil change-over procedure;

(5) VOC management plan (for crude oil tankers);

(6) Shipboard marine pollution emergency plan or shipboard marine pollution emergency plan for noxious liquid substances (for chemical tankers or NLS tankers);

(7) NO_x emission control/measurement procedures.

3.2.2.2 The following plans and information are to be submitted for approval:

(1) Arrangement of cargo tanks and ballast tanks, including drawings showing cargo and ballast pipe systems, and overflow protection arrangement (for oil tankers, chemical tankers and NLS tankers);

(2) Arrangement of fuel oil storage, settling and daily service tanks, including overflow protection arrangement;

(3) Arrangement of fuel oil tanks and piping;

(4) Capacity of bilge water holding tanks (if fitted), sludge tanks and slop tanks together with piping arrangement;

- (5) Arrangement of cargo oil and non-cargo-oil loading and unloading facilities, including connections, drip trays and drainage systems;
- (6) Arrangement plan of ballast water system, including details of ballast water treatment;
- (7) Arrangement and details of sewage system, including treatment equipment, including capacity of storage tank and treatment capacity etc.;
- (8) Sketch and details of incinerators and associated piping and monitoring equipment;
- (9) Arrangement and details of exhaust gas cleaning system;
- (10) Sketch and details of garbage storage or treatment system;
- (11) Details of fire-extinguishing media used in fixed fire-extinguishing systems and portable fire extinguishers, including names, quantities, etc.;
- (12) Arrangement plan and details of boil-off gas recovery system;
- (13) Any information related to additional environmental protection requirements of the flag State Administration or the Owner of the ship.

3.3 Control of discharge of water pollutants

3.3.1 Control of discharge of oil pollutants

3.3.1.1 The OIL1 notation may be assigned to ships complying with the following applicable requirements:

- (1) The 15 ppm oil filtering equipment used for machinery space bilge water is to be provided with an alarm and an automatic stopping device so that alarm will be activated and the discharge overboard automatically stopped when the oil content of any effluent from oily bilge water in machinery spaces exceeds 15 ppm.
- (2) The sludge tank discharge piping and bilge-water piping are not to be connected except that they may be connected to a common piping leading to the standard discharge connection.
- (3) Deck connections of fueling stations of fuel oil, lubricating oil and other oils (e.g. hydraulic oil) are to be provided with drip trays having a closed drainage system leading to a deck collecting tank or slop tank.
- (4) Vent piping and overflow piping of fuel oil tanks, lubricating oil tanks, hydraulic oil tanks and other tanks are to be provided with drip trays capable of collecting spilled oil. Means are to be provided to clean the spilled oil in order to prevent overboard discharge.
- (5) The fueling tank of fuel oil, lubricating oil, hydraulic oil and other oils is to be provided with high level alarm to prevent overflow. Where the internal tank is so designed that in case of overflow, it will not lead to environmental pollution, the high level alarm may not be fitted.
- (6) Cargo oil tanks are to be provided with high level alarm or overflow protection measures.
- (7) Both sides of the main deck within the cargo area of oil tanker are to be fitted with continuous coaming from the fore end to the aft end of cargo area, in order to prevent the discharge into the sea of spilled oil during cargo operations on deck. The height of coaming is to be determined in accordance with the size, type, arch, trim and stability of the ship. The main deck within cargo areas is also to be provided with a drainage system of spilled oil capable of draining such oil into a deck collecting tank or slop tank.

(8) Connections of the cargo oil manifold on an oil tanker are to be provided with drip trays having a closed drainage system leading to a deck collecting tank or slop tank.

(9) For oil tankers of 600 tonnes deadweight and above but less than 5,000 tonnes deadweight, cargo oil tanks are to be protected by wing and double bottom tanks having a minimum protection distance as required below:

- ① For wing tanks, the minimum width $w = 0.4 + \frac{2.4DWT}{20000} (m)$, the minimum value of $w = 0.76$ m

where: DWT — tonnes deadweight of ship.

- ② For double bottom tanks, the minimum height $h = B/15$ (m), the minimum value of $h = 0.76$ m.

where: B — moulded breadth of ship.

(10) Carriage of ballast water in the fuel oil tanks or carriage of fuel oil in the ballast water tanks is prohibited.

3.3.1.2 The OIL2 notation may be assigned to ships complying with the following applicable requirements in addition to the applicable requirements of 3.3.1.1 above:

(1) The oil content of any oily bilge effluent from the engine room is not to exceed 5 ppm. The alarm device of bilge water is to be set at 5 ppm, which is to be calibrated at least once every 5 years. The calibration certificate or the complete calibration record is to be kept on board the ship and readily available for inspection.

(2) As an alternative to (1) above, the ship is to be provided with oily bilge water holding tanks of sufficient capacity to retain all oily bilge water on board so as to facilitate the subsequent discharge to reception facilities. Piping to and from oily bilge water holding tanks is to have no direct connection overboard, other than the standard discharge connection referred to in MARPOL Annex I.

(3) For drip trays mentioned in 3.3.1.1(3) of this Chapter, the minimum capacity is to comply with the following requirements:

- ① for ships greater than 1600 GT: 0.16 m³;
② for ships between 300 GT and 1600 GT: 0.08 m³.

(4) For drip trays mentioned in 3.3.1.1(4) of this Chapter, the minimum capacity is to comply with the following requirements:

- ① for ships greater than 1600 GT: 0.08 m³;
② for ships between 300 GT and 1600 GT: 0.04 m³.

(5) For continuous coaming fitted on the deck within cargo area mentioned in 3.3.1.1(7) of this Chapter, the following height requirements are at least to be complied with:

- ① for oil tankers of 100000 DWT and above: the transverse coaming at the fore end is 0.25 m in height with transition gradually made towards the aft end of cargo area and connected to the transverse coaming at the aft end, which is 0.30 m in height;
② for oil tankers of less than 100000 DWT: the transverse coaming at the fore end is 0.10 m in height with transition gradually made towards the aft end of cargo area and connected to the transverse coaming at the aft end, which is 0.30 m in height.

(6) For drip trays mentioned in 3.3.1.1(8) of this Chapter, the arrangement and minimum size are to comply with the following requirements:

- ① length: the fore and the aft ends of manifolds to be included;
- ② width: at least 1.8 m, and approximately 1.2 m beyond the end of flange of manifolds;
- ③ depth: at least 0.3 m.

(7) All oil fuel tanks (except for overflow tanks) with an individual capacity greater than 30 m³ are to be arranged to be protected by wing tanks and double bottom tanks. However the aggregate capacity of oil fuel tanks with an individual capacity not greater than 30 m³ is not to be greater than 600 m³. The requirements for protective positions of wing tanks and double bottom tanks are as follows:

- ① Oil fuel tanks are to be located above the moulded line of the bottom shell plating nowhere less than the distance h as specified below:

$$h = B/20 \text{ m or}$$

$$h = 2.0 \text{ m, whichever is the lesser.}$$

The minimum value of $h = 0.76 \text{ m}$.

In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the oil fuel tank boundary line is to run parallel to the line of the midship flat bottom as shown in Figure 3.3.1.2(7)①.

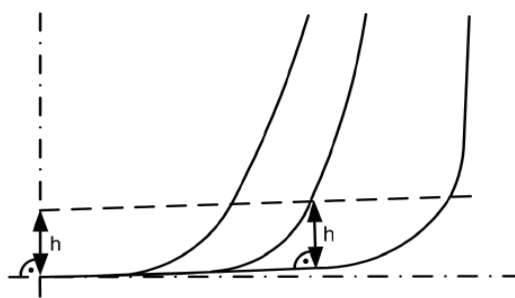


Figure 3.3.1.2(7)① Oil fuel tank boundary line

- ② For ships having an aggregate oil fuel capacity of less than 5,000 m³, oil fuel tanks are to be located inboard of the moulded line of the side shell plating, nowhere less than the distance W which, as shown in Figure 3.3.1.2(7)②, is measured at any cross-section at right angles to the side shell, as specified below:

$$W = 0.4 + 2.4C/20000 \text{ m}$$

where: C – Tank capacity, in m³.

The minimum value of $W = 1.0 \text{ m}$; however, for individual tanks with an oil fuel capacity of less than 500 m³ the minimum value is 0.76 m.

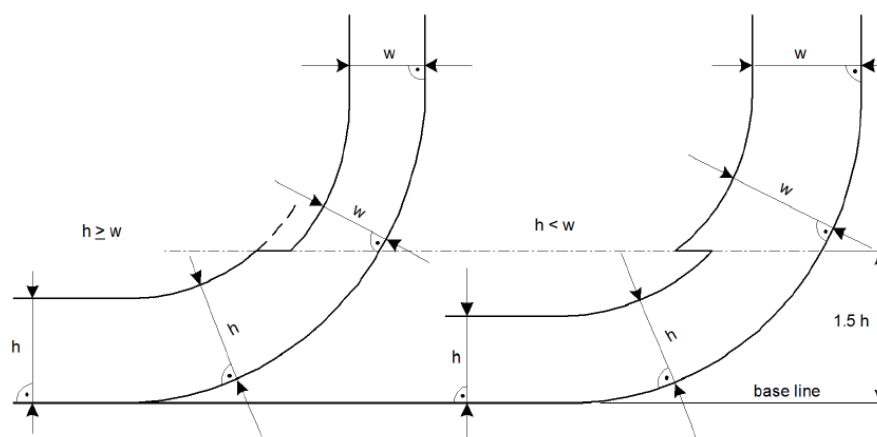


Figure 3.3.1.2(7)② Oil fuel tank boundary line

- ③ For ships having an aggregate oil fuel capacity of 5,000 m³ and over, oil fuel tanks are to be located inboard of the moulded line of the side shell plating, nowhere less than the distance W which, as shown in Figure 3.3.1.2(7)②, is measured at any cross-section at right angles to the side shell, as specified below:

$$W = 0.5 + C/20000 \text{ m or}$$

$$W = 2.0 \text{ m, whichever is the lesser.}$$

The minimum value of $W = 1.0$ m.

where: C – Tank capacity, in m³.

- ④ Lines of oil fuel piping located at a distance from the ship's bottom of less than h , as defined in ① above, or from the ship's side less than W , as defined in ② and ③, are to be fitted with valves or similar closing devices within or immediately adjacent to the oil fuel tank. These valves are to be capable of being brought into operation from a readily accessible enclosed space the location of which is accessible from the navigation bridge or propulsion machinery control position without traversing exposed freeboard or superstructure decks. The valves are to close in case of remote control system failure and are to be kept closed at sea at any time when the tank contains oil fuel except that they may be opened during oil fuel transfer operations.
- ⑤ Suction wells in oil fuel tanks may protrude into the double bottom below the boundary line defined by the distance h provided that such wells are as small as practicable and the distance between the well bottom and the bottom shell plating is not less than $0.5h$.

(8) Cargo oil tanks of any oil tanker are to be arranged to be protected by double bottoms and double side skins. For oil tankers of less than 600 tonnes deadweight, cargo oil tanks are to be protected by wing tanks and double bottom tanks having a minimum protection distance required by 3.3.1.1(9) above.

3.3.1.3 Where environmentally acceptable lubricants are used for oil-to-sea interfaces or equivalent measures are adopted, the EAL notation may be assigned provided that the following requirements are satisfied:

(1) Equipment having oil-to-sea interfaces includes but not limited to controllable pitch propeller, thruster hydraulic fluid and other equipment that might have lubrication discharges from oil seals and surfaces, such as paddle wheel propulsion, stern tubes, thruster bearings, stabilizers, rudder bearings, azimuth thrusters, podded propulsors, and wire rope and mechanical equipment subject to immersion.

(2) As an alternative to (1) above, where there is sufficient evidence showing the non-existence of oil-to-sea interfaces onboard ships, e.g. the seawater-lubricated rudder bearings, water-lubricated bearings, and air seal system, descriptions are to be given in the EAL Report.

(3) The ship is to keep on board a Statement of Compliance for EAL issued by CCS.

3.3.1.4 The IBTS notation may be assigned to ships where the management and discharge arrangement of engine room bilge water comply with the following requirements:

(1) The management and discharge arrangement of engine room bilge water is to comply with IMO MEPC.1/Circ.642 on integrated bilge water treatment system and amendments related thereto.

(2) A Statement of Fact on Installation of an Integrated Bilge Water Treatment System (IBTS) issued by CCS is to be kept on board.

3.3.2 Control of discharge of noxious liquid substances

3.3.2.1 The NLS1 notation may be assigned to chemical tankers complying with the following applicable requirements:

(1) Both sides of the main deck within the cargo area of chemical tanker are to be fitted with continuous coaming from the fore end to the aft end of cargo area, in order to prevent the discharge into the sea of leakage during cargo operations on deck. The height of coaming is to be determined in accordance with the size, type, arch, trim and stability of the ship. The main deck within cargo areas is also to be provided with a drainage system capable of collecting leakages during cargo operations and draining cargo leakages into a deck collecting tank or slop tank.

(2) Connections of the cargo manifold of chemical tankers are to be provided with drip trays having a closed drainage system leading to a deck collecting tank or slop tank.

(3) Cargo tanks of chemical tankers are to be provided with restricted gauging system, unless a closed gauging system is required due to the cargo categories.

3.3.2.2 The NLS2 notation may be assigned to chemical tankers complying with the following applicable requirements in addition to applicable requirements of 3.3.2.1 above:

(1) The structural arrangement of chemical tankers is at least to comply with the requirements for double side skins and double bottoms of type 2 chemical tankers in Chapter 2 of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, unless type 1 chemical tankers are required due to the cargo categories.

(2) The maximum allowable quantity of cargo residue remaining in each cargo tank and its associated piping of chemical tankers is not to exceed 50L.

(3) Cargo tanks of chemical tankers are to be provided with a closed gauging system and overflow alarm device independent from the closed gauging system.

(4) For continuous coaming fitted on the deck within cargo area mentioned in 3.3.2.1(1) of this Chapter, the following height requirements are at least to be complied with:

- ① for chemical tankers of 100000DWT and above: the transverse coaming at the fore end is 0.25 m in height with transition gradually made towards the aft end of cargo area and connected to the transverse coaming at the aft end, which is 0.30 m in height;
- ② for chemical tankers of less than 100000DWT: the transverse coaming at the fore end is 0.10 m in height with transition gradually made towards the aft end of cargo area and connected to the transverse coaming at the aft end, which is 0.30 m in height.

(5) For drip trays mentioned in 3.3.2.1(2) of this Chapter, the arrangement and minimum size are to comply with the following requirements:

- ① length: to include the fore and the aft ends of manifolds;
- ② width: at least 1.8 m, and approximately 1.2 m beyond the end of flange of manifolds;
- ③ depth: at least 0.3 m.

3.3.3 Control of discharge of sewage

3.3.3.1 The SC notation may be assigned to ships complying with the following applicable requirements:

(1) The ship is to be provided with a sewage treatment plant. The sewage is discharged after treatment. The treated sewage effluent is to meet effluent standards given in 4.2 of the annex to resolution MEPC.227(64).

(2) As an alternative to (1) above, the sewage from the ship is not discharged into the sea but to the reception facilities. The ship is to be provided with sewage holding tank of sufficient capacity and pipelines discharging the sewage to the reception facilities. The holding tank is to have capacity for the retention of all sewage, having regard to the operation of the ship, the number of persons on board and other relevant factors^①. The holding tank is to have a means to indicate visually the amount of its contents, which may be a liquid level meter, observation port, manual or automatic liquid level measuring device.

(3) The vent piping of sewage treatment system and sewage holding tank is to be independent from other vent piping.

(4) The ship is to keep on board a sewage management plan, which is to be approved by CCS. Such plan is to provide guidance to the crew on management of sewage treatment and discharge of sewage. The sewage management plan is at least to include the following:

- ① ship name and identification number;
- ② sketch of sewage treatment system, holding tanks of sewage and all relevant piping arrangement;
- ③ management and operational procedures of sewage;
- ④ means and method of recording all sewage discharges to shore reception facilities or to the sea. The recorded data is to include the date, place and quantity of such discharges. For discharges from the sewage treatment system, the time of activating and stopping the system is to be recorded in lieu of the quantity discharged. The discharge of untreated sewage in emergency is also to be recorded

3.3.4 Control of discharge of grey water

3.3.4.1 The GWC notation may be assigned to ships carrying control of grey water in accordance with the requirements for equipment and discharge as specified in MARPOL Annex IV and complying with the following applicable requirements:

① When the other clear documents are not provided, the capacity of the holding tank is to be calculated with the following methods: 1) when the voyage time of the ship from the departing port to the discharge area required by the port Administration exceeds 24 h, 70 L for per person for one day and night is to be taken; 2) when the voyage time is between 8 h to 24 h, 35 L for per person for one day and night is to be taken; 3) when the voyage time is between 4 h to 8 h, 18 L for per person for one day and night is to be taken; 4) when the voyage time is between 1 h to 4 h, 9 L for per person for one day and night is to be taken; 5) when the voyage time is less than 1 h, 6 L for per person for one day and night is to be taken. If the ship is fitted with the toilets of the vacuum type, the above values of the different voyage times may be reduced by half.

(1) The ship is to be provided with a treatment system for grey water. The discharge after treatment is to comply with the standard specified in resolution MEPC.227(64). Where the sewage treatment system fitted onboard treats both sewage and grey water, the treatment capacity of the sewage treatment system is to meet the treatment demand of both sewage and grey water subject to type approval.

(2) As alternative to 3.3.4.1 (1) above, where the grey water is held onboard for discharge to shore reception facilities or discharge to the sea only at a distance of more than 12 n miles from the nearest land, grey water holding tanks are to be provided, the capacity of which can be calculated for the number of persons onboard and voyage duration with 125 L/person/day. Where sewage and grey water share the same holding tank, the capacity of the tank is to be equal to the sum of the capacities of both the sewage holding tank and grey water holding tank.

(3) The grey water holding tank is to be fitted with high level alarm.

(4) The vent pipes of grey water treatment system and holding tanks is to be independent of other vent piping systems.

(5) In addition to the requirements of 3.3.4.1 (1) to 3.3.4.1 (4) above, for grey water generated in the galley, prior to its discharge, discharge to the holding tank or treatment by the sewage treatment plant, the grey water is to flow through the oil water separator for oil water separation.

(6) The ship is to keep on board a grey water management plan, which is to be approved by CCS. Such plan is to provide guidance to the crew on grey water treatment and discharge management. The grey water management plan may be combined with the sewage management plan and is to include the following as a minimum:

- ① name and identification number of the ship;
- ② diagrams of the grey water treatment system, holding tank and all relevant piping arrangement;
- ③ management and operational procedures of grey water;
- ④ means and method of recording all grey water discharge to shore reception facilities or to the sea, and amount of water reuse (where applicable). The recorded data is to include the date, place and quantity of such discharges; the speed of the ship and its nearest distance to shore are also to be recorded for discharges to the sea.

3.3.5 Control of discharge of garbage

3.3.5.1 The RC notation may be assigned to ships complying with the following requirements:

(1) The disposal of food wastes is not permitted except when they have been passed through a comminuter or grinder. Such comminuted or ground food wastes are to be capable of passing through a screen with openings no greater than 25 mm.

(2) The ship is to keep on board a garbage management plan complying with IMO requirements, which is to be approved by CCS and contain management measures in compliance with 3.3.5.1 (1) above.

3.3.6 Documentation requirements

3.3.6.1 For ships assigned corresponding notations for discharge control of water pollutants, the following applicable information is to be submitted for approval in addition to applicable plans and documents required by 3.2.2 of this Chapter:

3.3.6.2 For ships applying for the EAL notation, the following is to be submitted:

- (1) EAL report: the use of EAL of all oil-to-sea interfaces is to be described in the report;
- (2) Air sealing system (if any): alarm table and conversion plan (where applicable) of air sealing system.

3.3.6.3 For ships applying for the NLSx notation, the following is to be submitted:

- (1) overflow protection arrangement;
- (2) plan of cargo tank measuring system.

3.3.6.4 The following applicable procedural documents:

- (1) Sewage Management Plan;
- (2) Grey water Management Plan;
- (3) Garbage Management Plan.

3.4 Control of emission of air pollutants

3.4.1 Control of NO_x emission from diesel engines

3.4.1.1 The NEC1 notation may be assigned to ships constructed prior to 1 January 2011, where NO_x emission from each marine diesel engine with a power output of more than 130 kW installed on the ship is within the following limits:

- (1) 14.4g/kW·h, when $n < 130\text{r/min}$;
- (2) $44.0 \cdot n^{(-0.23)}\text{g/kW}\cdot\text{h}$, when $130\text{r/min} \leq n < 2000\text{r/min}$;
- (3) 7.7g/kW·h, when $n \geq 2000\text{r/min}$.

where n is rated engine speed (crankshaft revolutions per minute).

3.4.1.2 The NEC2 notation may be assigned to all ships, where NO_x emission from each marine diesel engine with a power output of more than 130 kW installed on the ship is within the following limits:

- (1) 3.4g/kW·h, when $n < 130\text{r/min}$;
- (2) $9.0 \cdot n^{(-0.2)}\text{g/kW}\cdot\text{h}$, when $130\text{r/min} \leq n < 2000\text{r/min}$;
- (3) 2.0g/kW·h, when $n \geq 2000\text{r/min}$.

where n is rated engine speed (crankshaft revolutions per minute).

3.4.1.3 The test procedures and measurement methods for NO_x emission from diesel engines are to comply with the requirements of CCS Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines.

3.4.1.4 The NEC1 or NEC2 notation may be assigned to ships on which NO_x reducing devices are fitted to reduce NO_x emissions below the limits specified in 3.4.1.1 or 3.4.1.2. Such devices are to be approved by CCS.

3.4.1.5 The requirements of this regulation do not apply to emergency engines, or engines fitted on lifeboats, or engines of devices or equipments used only in emergencies.

3.4.2 Control of SO_x emission

3.4.2.1 The SEC notation may be assigned to ships when the sulphur content of any fuel oil used or carried for use on board the ship does not exceed 0.10%*m/m*.

3.4.2.2 As an alternative to the requirements of 0.10%*m/m* low Sulphur fuel oil in 3.4.2.1 above, an approved exhaust gas cleaning system (EGCS) or other approved measures may be used to control SO_x emissions within the corresponding limit. The SO_x emission limit corresponding to the fuel oil sulphur content of 0.10%*m/m* above is to comply with the provisions specified in resolution MEPC.259(68), as amended.

3.4.3 Control of black carbon emission

3.4.3.1 The BC20 notation may be assigned to ships when the black carbon emission reduction technology is used by the ship to reduce the emission of black carbon from diesel engines with a power output of more than 130 kW on board by 20% and over as compared to that before the application of the black carbon emission reduction technology.

3.4.3.2 The BC70 notation may be assigned to ships when the black carbon emission reduction technology is used by the ship to reduce the emission of black carbon from diesel engines with a power output of more than 130 kW on board by 70% and over as compared to that before the application of the black carbon emission reduction technology.

3.4.3.3 Black carbon may be tested by any of the methods recommended by IMO, i.e. Filter Smoke Number (FSN), Photo -Acoustic Spectroscopy (PAS) or Laser Induced Incandescence (LII). Recognized national and international standards may be used as the test specification. The test cycles are to comply with relevant requirements of CCS Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines.

3.4.3.4 The requirements of this regulation do not apply to emergency engines, or engines fitted on lifeboats, or engines of devices or equipments used only in emergencies.

3.4.4 Control of VOCs emission from tankers

3.4.4.1 The VCS notation may be assigned to tankers, where vapour emission control systems for cargoes of cargo tanks complying with applicable requirements of Chapter 15, PART THREE of the Rules for Classification of Sea-going Steel Ships are provided on board.

3.4.4.2 The VCS-T notation may be assigned to service ships receiving cargo vapour, where vapour emission control systems for cargoes of cargo tanks complying with applicable requirements of Chapter 15, PART THREE of the Rules for Classification of Sea-going Steel Ships are provided on board.

3.4.5 Control of emission from shipboard incineration

3.4.5.1 The INC notation may be assigned to ships complying with the following requirements:

(1) Unless the ship is fully capable of transferring the garbage to the shore, at least one incinerator is to be installed on board, which is to be type approved by CCS in accordance with IMO resolution MEPC.244(66) and have a valid IMO type approval certificate.

(2) All operations of the incinerator are to be recorded in the Garbage Record Book or Oil Record Book, as appropriate.

3.4.6 Control of emission of ozone-depleting substances

3.4.6.1 The requirements for RSC1 and RSC2 emission control notations for ozone-depleting substances (refrigerants) of this paragraph apply to refrigerated cargo installations, central air conditioning systems and centralized refrigeration systems of all ships, but do not apply to permanently sealed equipment without refrigerant charging connection or permanently sealed equipment without removable parts containing ozone-depleting substances.

3.4.6.2 The RSC1 notation may be assigned to ships complying with the following applicable requirements:

(1) Refrigerating systems are to be provided with suitable maintenance isolation means to prevent significant leaks of refrigerants during maintenance or repairs. However, unavoidable minimal release of refrigerants associated with refrigerant recovery is acceptable.

(2) In order to recover refrigerants, compressors are to be capable of evacuating refrigerants within the system into a liquid receiver. Additionally, recovery units are to be capable of evacuating a system either into the existing liquid receiver or into suitable reservoirs dedicated for this purpose. The capacity of the liquid receiver or reservoirs is to be sufficient to contain all refrigerants of the largest refrigerating unit that can be isolated.

(3) The annual refrigerant leakage rate of each system is to be less than 10% of its total charge. A leakage detection system is to be provided to monitor continuously the spaces into which the refrigerant could leak. An alarm is to be activated to give warning in a permanently manned location when the concentration of refrigerant in the space exceeds a predetermined limit (e.g. 25 ppm for ammonia). Remedial measures are to be implemented when any leak is detected.

(4) Where different refrigerants are in use, means are to be provided to prevent them from being mixed.

(5) The ship is to keep on board a refrigerant management plan which is at least to include the following:

- ① ship name and identification number;
- ② list of all refrigerating systems as well as sketch and component description (including leakage detection system);
- ③ means adopted to manage and control consumption, leakage, evacuation and disposal of refrigerants together with the remedial measures in the event of any leakage as stated in (3) above;
- ④ means and method of recording replacement, leakage, recovery, charging and disposal of refrigerants, including at least date, system type, refrigerant type, initial system charge and refrigerant level, charging amount, recovery amount, leakage type and remedial measures.

(6) The ship is to establish and maintain a list of refrigerants on board and a record book required by 3.4.6.2(5)④ above, which are to be kept throughout the life time of the system. The record of each item is to be kept on board for at least 3 years and available for check by the surveyor.

3.4.6.3 The RSC2 notation may be assigned to ship complying the following applicable requirements in addition to the applicable requirements of 3.4.6.2 :

(1) For refrigerated cargo installations, central air conditioning systems and centralized refrigeration systems of ships, the ozone depletion potential (ODP) is to be 0 and the global warming potential (GWP) less than 2000. Both ODP and GWP are to be determined according to the definitions given in the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987.

3.4.6.4 The use of halons or halocarbons as fire-fighting media is to be prohibited for fixed fire-extinguishing systems and portable fire extinguishers. Natural substances are to be used as fire-fighting media for fire-extinguishing systems insofar as practicable, e.g., argon, nitrogen, water mist, carbon dioxide. Any other alternative product used is to have a GWP of less than 2000.

3.4.7 Documentation requirements

3.4.7.1 For ships to be assigned with notations for emission control of air pollutants, the following applicable information is to be submitted for approval in addition to applicable plans and documents required by 3.2.2 of this Chapter.

3.4.7.2 NO_x emission control

- (1) engine technical file or emission test report approved by CCS;
- (2) arrangement of NO_x emission control.

3.4.7.3 SO_x emission control

- (1) arrangement of SO_x emission control;
- (2) when applied as equivalent, review of plans and arrangement of exhaust gas cleaning system or other technical methods.

3.4.7.4 Black carbon emission control

- (1) emission test report approved by CCS;
- (2) arrangement of black carbon emission control.

3.4.7.5 VOC emission control

(1) For ships to be assigned with VCS or VCS-T notation, the following plans and documents are to be submitted for approval :

- ① Diagrammatic plan of the vapour piping system, indicating material specifications, scantlings, ratings, joining details and fittings;
- ② Diagrammatic plan of the gauging system and overfill protection, indicating manufacturer and type of the equipment or instruments, hazardous area locations, location of electrical equipment in gas–dangerous spaces and safe certificates of the electrical instruments intended to be used in hazardous locations, electrical schemes concerning the alarm system supply, electrical schemes concerning the intrinsically safe circuits;
- ③ Diagrammatic plan of the venting system, indicating necessary data for verifying the venting capacity of the pressure/vacuum valves;
- ④ Pressure drop calculation comparing cargo transfer rates versus pressure drops from the farthest tanks to the vapour connection, including any possible hoses;
- ⑤ Calculations showing the time available between alarm setting and overfill at maximum loading rate for each tank;
- ⑥ Instruction manual.

(2) For ships to be assigned with VCS-T notation, documentation of the explosion-proof devices, including equipment manufacturer, type and inspection documents, is also to be submitted for information.

3.4.7.6 Shipboard incineration emission control

- (1) type approval certificate and instructions of incinerators;
- (2) arrangement of shipboard incinerators.

3.4.7.7 Ozone-depleting substance emission control

- (1) diagrammatic plan of refrigerating equipment and arrangement;
- (2) refrigerant management plan.

3.5 Control of use of hazardous materials

3.5.1 Control of harmful anti-fouling systems

3.5.1.1 The AFS+ notation may be assigned to ships where the anti-fouling system applied to the ship's hull is not to contain any biocides.

3.5.1.2 Biocide-free anti-fouling system includes but not limited to the following:

- (1) Organic silicon;
- (2) Organic fluorine fouling-release paint;
- (3) Environmental protection paint such as bionic antifouling.

3.5.1.3 The AFS notation may be assigned to ships where the anti-fouling system applied to the ship's hull is not to contain organotin compounds as biocides.

3.5.2 Control of hazardous materials

3.5.2.1 The GPR notation may be assigned to ships complying with the following requirements:

(1) The ship is to carry the Inventory of Hazardous Materials in compliance with Regulation 5 of the Annex to Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 of IMO.

(2) The Inventory of Hazardous Materials is to be developed in accordance with Guidelines for the Development of the Inventory of Hazardous Materials, 2015 adopted by IMO by resolution MEPC.269(68) and to be verified by CCS in accordance with the Guidelines for Development and Survey of the Inventory of Hazardous Materials of Ships.

3.5.2.2 The GPR+ notation may be assigned to ships when sampling testing and verification are further carried out in accordance with 3.6.8 or 4.4.10 of CCS Guidelines for Development and Survey of the Inventory of Hazardous Materials of Ships, in addition to complying with the requirements of 3.5.2.1.

3.5.2.3 The GPR(EU) notation may be assigned to ships complying with the following requirements:

(1) The ship is to carry the Inventory of Hazardous Materials in compliance with Article 5 of Regulation (EU) No. 1257/2013.

(2) The Inventory of Hazardous Materials is to be developed in accordance with Guidelines for the Development of the Inventory of Hazardous Materials, 2015 adopted by IMO by resolution MEPC.269(68). In addition, the use of perfluorooctane sulfonic acid and brominated flame retardant is to comply with relevant requirements of Regulation (EU) No 1257/2013.

3.5.2.4 The GPR(EU)+ notation may be assigned to ships when sampling testing and verification are further carried out in accordance with 3.6.8 or 4.4.10 of CCS Guidelines for Development and Survey of the Inventory of Hazardous Materials of Ships, in addition to complying with the requirements of 3.5.2.3.

3.5.3 Documentation requirements

3.5.3.1 For ships to be assigned with notations for control of use hazardous materials, information is to be provided in accordance with the following requirements:

(1) For control of harmful anti-fouling systems, information is to be submitted in accordance with relevant requirements of CCS Guidelines for Survey of Anti-fouling Systems on Ships.

(2) For control of hazardous materials, information is to be submitted in accordance with relevant requirements of CCS Guidelines for Development and Survey of the Inventory of Hazardous Materials of Ships.

PART II REQUIREMENTS FOR SEA-GOING SHIPS ENGAGED ON DOMESTIC VOYAGES

CHAPTER 4 REQUIREMENTS FOR ECOLOGICAL PROTECTION

4.1 General requirements

4.1.1 This Chapter specifies the relevant requirements of ecological protection notation Gd-ECO for sea-going ships engaged on domestic voyages.

4.1.2 Ecological protection elements for green eco-ships include the following two aspects:

(1) GHG emission control: including requirements for CO₂ emission design index and CO₂ emission operational management.

(2) Environmental friendliness: including the requirements for comfort onboard (vibration, compartment noise, indoor climate), control of underwater noise and environmental noise.

4.1.3 Class notations related to ecological protection of green eco-ships are as follows:

(1) Class notations of ecological protection for green eco-ships include:

Gd-ECO (X): means that the requirements of some sub-elements of ecological protection are satisfied. Where X represents the class notation of a corresponding sub-elements of ecological protection.

(2) Class notations of GHG emission control include:

CDx: means class notation of CO₂ emission design index, where x represents the percentage ratio of the ship's Attained EEDI value lower than the Required EEDI value for that ship;

COM: means class notation of CO₂ emission operational management, indicating the levels of ship energy efficiency management and the company energy efficiency management .

(3) Class notations of environmental friendliness include:

VIBx: means class notation of comfort onboard (vibration), where "x" represents the grade of comfort onboard (vibration);

NOIx: means class notation of comfort onboard (compartment noise), where "x" represents the grade of comfort onboard (compartment noise);

CLx: means class notation of comfort onboard (indoor climate) , where "x" stands for the grade of comfort onboard (indoor climate);

UW: means class notation of underwater noise, indicating the level of control of the adverse effects of underwater noise caused by the ship on aquatic life;

RN: means class notation of environmental noise, indicating the level of control of the adverse effects of noise caused by the ship on living and working environment of residents on shore.

4.2 GHG emission control

4.2.1 Definitions and application

4.2.1.1 For the purpose of this regulation, the following definitions apply:

- (1) *Bulk carrier* means a ship which is constructed generally with single deck, top-side tanks and hopper side tanks in cargo spaces, and is intended primarily to carry dry cargo in bulk, and includes such types as ore carriers and combination carriers.
- (2) *Tanker* means an oil tanker as defined in Chapter 2, or a chemical tanker or an NLS tanker as defined in Chapter 3 of PART FIVE of Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Non-international Voyages
- (3) *Container ship* means a ship designed exclusively for the carriage of containers in holds and on deck.
- (4) *LNG carrier* means a cargo ship constructed or adapted and used for the carriage in bulk of liquefied natural gas(LNG).
- (5) *Conventional propulsion* means a method of propulsion where a main reciprocating internal combustion engine(s) is the prime mover and coupled to a propulsion shaft directly or through a gear box.
- (6) *Non-conventional propulsion* means a method of propulsion, other than conventional propulsion, including diesel-electric propulsion, turbine propulsion and hybrid propulsion systems.

4.2.1.2 Regulation 4.2.2 of this Chapter applies to sea-going ships engaged on domestic voyages which fall within the ship types as defined in 4.2.1.1 (1) to (4) above.

4.2.1.3 Regulation 4.2.2 of this Chapter does not apply to ships having non-conventional propulsion systems which fall within the ship types as defined in 4.2.1.1(1) to (3) above, except that it applies to LNG carriers having diesel-electric propulsion and turbine propulsion systems.

4.2.1.4 Regulation 4.2.2 of this Chapter does not apply to ships not propelled by mechanical means such as barges, and platforms (including FPSOs and FSUs) and drilling units.

4.2.2 Requirements for CO₂ emission design index for ships

4.2.2.1 The CD_x notation of CO₂ emission design index may be assigned to a ship with *the Attained EEDI* less than or equals to *the Required EEDI*, of which x can be obtained from the following formula:

$$x\% = \frac{\text{Required EEDI} - \text{Attained EEDI}}{\text{Required EEDI}} \times 100\%$$

where x takes only the integer by rounding off the decimal part..

4.2.2.2 *The Required EEDI* value of a ship is to be determined by the following formula and the relevant parameters given in Table 4.2.2.2.

$$\text{Required EEDI} = a \times b^{(-c)}$$

Where: b is the Capacity.

Parameters for Determination of Required EEDI**Table 4.2.2.2**

Ship type	<i>a</i>	Capacity <i>b</i>	<i>c</i>
Bulk carrier	749.9	DWT	0.4673
Tanker	609.3	DWT	0.4337
Container ship	1107.0	DWT	0.4406
LNG carrier	2253.7	DWT	0.474

4.2.2.3 If the design of a ship falls into more than one of the ship type definitions specified in Table 4.2.2.2, the *Required EEDI* of the ship is to be the *lowest Required EEDI*.

4.2.2.4 The Attained EEDI for ships is to be calculated in accordance with Appendix 1-2 of the Rules.

4.2.2.5 The Attained EEDI is to be verified in accordance with CCS Guidelines on Survey and Verification of the Energy Efficiency Design Index (EEDI) of Ships.

4.2.2.6 The ship is to be designed so as to have sufficient installed power to maintain the manoeuvrability in adverse conditions while meeting the corresponding *Required EEDI*.

4.2.3 Requirements for CO₂ emission operational management of ships

4.2.3.1 The COM notation for CO₂ emission operational management may be assigned to ships complying with the requirements of 2.3.3 of the Rules.

4.2.4 Documentation requirements

4.2.4.1 For ships to be assigned with notations for GHG emission control, the documents are to be submitted in compliance with the requirements of 2.3.4 of the Rules.

4.3 Environmental friendliness

4.3.1 Vibration

4.3.1.1 The corresponding VIBx notation of vibration comfort may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 2.5.1 of the Rules.

4.3.2 Compartment noise

4.3.2.1 The corresponding NOIx notation of noise comfort may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 2.5.2 of the Rules.

4.3.3 Indoor climate

4.3.3.1 The corresponding CLx notation of indoor climate may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 2.5.3 of the Rules.

4.3.4 Underwater noise

4.3.4.1 The corresponding UW notation of underwater radiated noise may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 2.5.4 of the Rules.

4.3.5 Environmental noise

4.3.5.1 The corresponding RN notation of environmental noise may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 2.5.5 of the Rules.

4.3.6 Documentation requirements

4.3.6.1 For ships to be assigned with notations for environmental friendliness, the documents are to be submitted in accordance with 2.5.6 of the Rules.

CHAPTER 5 REQUIREMENTS FOR ENVIRONMENTAL PROTECTION

5.1 General requirements

5.1.1 This Chapter specifies the relevant requirements of environmental protection elements for Gd-EP class notation for sea-going ships engaged on domestic voyages.

5.1.2 Environmental protection elements include the following:

- (1) control of discharge of water pollutants, including control of discharge into the sea of oil, noxious liquid substances, harmful substances carried by sea in packaged form, sewage and grey water and garbage;
- (2) control of emission of air pollutants, including nitrogen oxides (NO_x) from marine engines, sulphur oxides (SO_x) and particulate matter (PM), carbon oxide (CO) and hydrocarbon (HC) from fuel combustion, volatile organic compounds (VOCs) from cargoes, ozone-depleting substances (ODS) from ship's fire-extinguishing systems and refrigeration systems, exhaust gas from onboard incineration;
- (3) control of use of hazardous materials, including prohibiting the use of hazardous materials such as harmful anti-fouling systems (AFS) and asbestos, control of use of other hazardous materials^①, prevention of pollution caused by dismantling of ships.

5.1.3 Class notations related to environmental protection of green eco-ships are as follows:

- (1) Class notations of environmental protection for green eco-ships include:

Gd-EP: means that only the mandatory and statutory requirements of Domestic Regulations etc. are complied with.

Gd-EP (X): means that the requirements of some sub-elements of environmental protection are higher than those of Domestic Regulations, where X represents class notation for sub-elements of environmental protection.

- (2) Class notations for control of discharge of water pollutants include:

OILx: means class notation for control of oil pollutants, where x represents the level of control of oil pollutants;

EAL: means environmental acceptable lubricants are used or other equivalent measures are adopted on the ship;

IBTS: means the ship satisfies the requirements for integrated bilge water treatment system;

NLSx: means class notation for control of noxious liquid substances, where x represents the level of control of noxious liquid substances;

SC: means class notation for control of discharge of sewage;

GWC: means class notation for control of discharge of grey water;

RC: means class notation for control of discharge of garbage.

- (3) Class notations for control of emission of air pollutants include the following:

^① Including 9 hazardous materials listed in Appendix 2 of the Hong Kong Convention.

NECx: means class notation for control of NO_x emission from diesel engines, where x represents the level of emission control;

SEC: means class notation for emission control of SO_x and particulate matter (PM) from ships;

VCS: means class notation for VOC emission control of cargoes of tankers;

VCS-T: means class notation for VOC emission control of cargoes of auxiliary ships;

RSCx: means class notation for management and emission control of refrigerant of refrigeration system of ships, where x represents the level of emission control;

INC: means class notation for emission control of incineration operation on board;

GBEC: means class notation for emission control of exhaust gas pollutants from diesel engines, indicating that the ship complies with phase II limit in GB 15097-2016 - Emission Limits and Measurement Methods of Exhaust Gas Pollutants from Ship Engines (China Phase I and II).

(4) Class notation for the control of use of hazardous materials:

AFS: means class notation for anti-fouling systems that do not use organotin compounds as biocides;

AFS+: means class notation for anti-fouling systems that do not contain any biocides;

GPR: means class notation for control of hazardous materials of ship, indicating that the ship has inventory of hazardous materials complying with the requirements of the convention.

5.2 Technical requirements for Gd-EP class notation

5.2.1 General requirements

5.2.1.1 The Gd-EP notation may be assigned to ships complying with the latest requirements in force of PART FIVE of Domestic Regulations, and holding the corresponding statutory certificates or document of compliance.

5.2.1.2 In addition, ships to be assigned the Gd-EP notation are to comply with the following requirements, as applicable:

(1) For ships with an aggregate oil fuel capacity of 600 m³ and above, the design of all oil fuel tanks with individual capacity greater than 30 m³ is to comply with the requirements for oil fuel tank protection of 2.4, Chapter 2, PART FIVE of Domestic Regulations.

(2) The use of ozone-depleting substances is prohibited in shipboard refrigerating systems (excluding permanently sealed equipment without refrigerant charging connection or permanently sealed equipment without removable parts containing ozone-depleting substances) and fire-extinguishing systems (including fixed fire-extinguishing systems and portable fire extinguishers).

(3) Diesel engines with an individual output power greater than 130 kW, other than emergency diesel engines, those installed on lifeboats or used solely for emergency purposes, are to comply with the nitrogen oxide (NO_x) emission limits as specified below:

① 14.4 g/kWh, when $n < 130 \text{ r/min}$;

② $44.0 \times n^{(-0.23)}$ g/kWh, when $130 \text{ r/min} \leq n < 2000 \text{ r/min}$;

③ 7.7 g/kWh, when $n \geq 2000$ r/min.

where n is rated engine speed (crankshaft revolutions per minute).

The test procedures and measurement methods are to comply with the requirements of CCS Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines.

5.2.2 Documentation requirements

5.2.2.1 The following operational procedural documents, where applicable, are to be approved and kept on board the ship:

- (1) Shipboard oil pollution emergency plan;
- (2) STS operations plan (only for oil tankers conducting STS operations);
- (3) Garbage management plan;
- (4) Fuel oil change-over procedure;
- (5) VOC management plan (for crude oil tankers);
- (6) Shipboard marine pollution emergency plan or shipboard marine pollution emergency plan for noxious liquid substances (for chemical tankers or NLS tankers);
- (7) NO_x emission control/measurement procedures.

5.2.2.2 The following plans and information are to be submitted for approval:

- (1) Arrangement of cargo tanks and ballast tanks, including drawings showing cargo and ballast pipe systems, and overflow protection arrangement (for oil tankers, chemical tankers and NLS tankers);
- (2) Arrangement of fuel oil storage, settling and daily service tanks, including overflow protection arrangement;
- (3) Arrangement of fuel oil tanks and piping;
- (4) Capacity of bilge water holding tanks (if fitted), sludge tanks and slop tanks together with piping arrangement;
- (5) Arrangement of cargo oil and non-cargo-oil loading and unloading facilities, including connections, drip trays and drainage systems;
- (6) Arrangement and details of sewage system, including treatment equipment, including capacity of storage tank and treatment capacity etc.;
- (7) Sketch and details of incinerators and associated piping and monitoring equipment;
- (8) Arrangement and details of exhaust gas cleaning system;
- (9) Sketch and details of garbage storage or treatment system;
- (10) Details of fire-extinguishing media used in fixed fire-extinguishing systems and portable fire extinguishers, including names, quantities, etc.;

(11) arrangement plan and details of boil-off gas recovery system;

(12) Any information related to additional environmental protection requirements of the flag State Administration or the Owner of the ship.

5.3 Control of discharge of water pollutants

5.3.1 Control of discharge of oil pollutants

5.3.1.1 The OIL1 notation may be assigned to ships complying with the applicable requirements of 3.3.1.1 of the Rules.

5.3.1.2 The OIL2 notation may be assigned to ships complying with the applicable requirements of 3.3.1.2 of the Rules.

5.3.1.3 The EAL notation may be assigned to ships complying with relevant requirements of 3.3.1.3 of the Rules.

5.3.1.4 The IBTS notation may be assigned to ships complying with relevant requirements of 3.3.1.4 of the Rules.

5.3.2 Control of discharge of noxious liquid substances

5.3.2.1 The NLS1 notation may be assigned to ships complying with the applicable requirements of 3.3.2.1 of the Rules.

5.3.2.2 The NLS2 notation may be assigned to ships complying with the applicable requirements of 3.3.2.2 of the Rules.

5.3.3 Control of discharge of sewage

5.3.3.1 The SC notation may be assigned to ships complying with applicable requirements of 3.3.3.1 of the Rules as well as the following requirements:

(1) When sewage is discharged after being treated by the sewage treatment plant when the ship is within 3 nautical miles from the nearest land, the ship is to be on the voyage.

(2) The requirement of (1) above is to be described in the sewage management plan.

5.3.4 Control of discharge of grey water

5.3.4.1 The GWC notation may be assigned to ships complying with the applicable requirements of 3.3.4 of the Rules.

5.3.5 Control of discharge of garbage

5.3.5.1 The RC notation may be assigned to ships complying with the applicable requirements of 3.3.5 of the Rules.

5.3.6 Documentation requirements

5.3.6.1 For ships to be assigned with notations for discharge control of water pollutants, the information is to be submitted in accordance with 3.3.6 of the Rules.

5.4 Control of emission of air pollutants

5.4.1 Control of emission of exhaust gas pollutants from diesel engines

5.4.1.1 The NEC1 notation may be assigned to sea-going ships engaged on domestic voyages constructed before 1 March 2015, where NO_x emission from each marine diesel engine with a single cylinder displacement of 30 L and above installed on the ship is within the following limits:

- (1) 14.4g/kW·h, when $n < 130\text{r/min}$;
- (2) $44.0 \cdot n^{(-0.23)}\text{g/kW}\cdot\text{h}$, when $130\text{r/min} \leq n < 2000\text{r/min}$;
- (3) 7.7g/kW·h, when $n \geq 2000\text{r/min}$.

where n is rated engine speed (crankshaft revolutions per minute).

5.4.1.2 The NECw notation may be assigned to all sea-going ships engaged on domestic voyages, where NO_x emission from each marine diesel engine with a single cylinder displacement of 30 L and above installed on board is within the following limits:

- (1) 3.4g/kW·h, when $n < 130\text{r/min}$;
- (2) $9.0 \cdot n^{(-0.2)}\text{g/kW}\cdot\text{h}$, when $130\text{r/min} \leq n < 2000\text{r/min}$;
- (3) 2.0g/kW·h, when $n \geq 2000\text{r/min}$.

where n is rated engine speed (crankshaft revolutions per minute).

5.4.1.3 The NEC1 or NEC2 notation may be assigned to ships on which NO_x reducing devices are fitted to reduce NO_x emissions below the limits specified in 5.4.1.1 or 5.4.1.2. Such devices are to be approved by CCS.

5.4.1.4 For assignment of the NEC1 or NEC2 notation, the test procedures and measurement methods for NO_x emission from diesel engines are to comply with the requirements of CCS Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines.

5.4.1.5 The GBEC notation may be assigned to sea-going ships engaged on domestic voyages, where emission of exhaust gas pollutants (CO, HC+NO_x, PM) from each marine diesel engine with a single cylinder displacement below 30 L installed on board is within the following limits of emission standards:

- (1) phase II limit in GB 15097-2016 - Limits and measurement methods for exhaust pollutants from marine engines (CHINA I、II) for rated power of 37 kW and above. The test procedures and measurement methods are to comply with the requirements of GB 15097-2016.
- (2) phase IV limit in GB 20891-2014 - Limits and measurement methods for exhaust pollutants from diesel engines of non-road mobile machinery(CHINA III、IV) for rated power below 37 kW. The test procedures and measurement methods are to comply with the requirements of GB 20891-2014.

5.4.1.6 The requirements of this regulation do not apply to emergency engines, or engines fitted on lifeboats, or engines of devices or equipments used only in emergencies.

5.4.2 Control of SO_x emission

5.4.2.1 The SEC notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.2 of the Rules.

5.4.3 Control of VOCs emission from tankers

5.4.3.1 The VCS notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.4.1 of the Rules.

5.4.3.2 The VCS-T notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.4.2 of the Rules.

5.4.4 Control of emission from shipboard incineration

5.4.4.1 The INC notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.5 of the Rules.

5.4.5 Control of emission of ozone-depleting substances

5.4.5.1 The RSC1 notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.6.2 of the Rules.

5.4.5.2 The RSC2 notation may be assigned to sea-going ships engaged on domestic voyages complying with the relevant requirements of 3.4.6.3 of the Rules.

5.4.6 Documentation requirements

5.4.6.1 For ships to be assigned with notations for emission control of air pollutants, the following applicable information is to be submitted for approval in addition to applicable plans and documents required by 5.2.2 of this Chapter.

5.4.6.2 Control of emission of exhaust gas pollutants from diesel engines

- (1) engine technical file or emission test report approved by CCS;
- (2) arrangement of control of emission of exhaust gas pollutants from diesel engines.

5.4.6.3 SO_x emission control

- (1) arrangement of SO_x emission control;
- (2) when applied as equivalent, review of plans and arrangement of exhaust gas cleaning system or other technical methods.

5.4.6.4 VOC emission control

(1) The following plans and documents are to be submitted for approval by ships for which the additional notation of VCS or VCS-T is requested:

- ① Diagrammatic plan of the vapour piping system, indicating material specifications, scantlings, ratings, joining details and fittings;
- ② Diagrammatic plan of the gauging system and overfill protection, indicating manufacturer and type of the equipment or instruments, hazardous area locations, location of electrical equipment in gas-dangerous spaces and safe certificates of the electrical instruments intended to be used in hazardous locations, electrical schemes concerning the alarm system supply, electrical schemes concerning the intrinsically safe circuits;

- ③ Diagrammatic plan of the venting system, indicating necessary data for verifying the venting capacity of the pressure/vacuum valves;
- ④ Pressure drop calculation comparing cargo transfer rates versus pressure drops from the farthest tanks to the vapour connection, including any possible hoses;
- ⑤ Calculations showing the time available between alarm setting and overfill at maximum loading rate for each tank;
- ⑥ Instruction manual.

(2) For ships for which the additional notation of VCS-T is requested, documentation of the explosion-proof devices, including equipment manufacturer, type and inspection documents, is also to be submitted for information.

5.4.6.5 Shipboard incineration emission control

- (1) type approval certificate and instructions of incinerators;
- (2) arrangement of shipboard incinerators.

5.4.6.6 Ozone-depleting substance emission control

- (1) diagrammatic plan of refrigerating equipment and arrangement;
- (2) refrigerant management plan.

5.5 Control of use of hazardous materials

5.5.1 Control of harmful anti-fouling systems

5.5.1.1 The AFS+ notation may be assigned to ships complying with the relevant requirements of 3.5.1.1 of the Rules.

5.5.1.2 The AFS notation may be assigned to ships complying with the relevant requirements of 3.5.1.3 of the Rules.

5.5.2 Control of hazardous materials

5.5.2.1 The GPR notation may be assigned to ships complying with the relevant requirements of 3.5.2.1 of the Rules.

5.5.3 Documentation requirements

5.5.3.1 For ships to be assigned with notations for control of use hazardous materials, information is to be submitted in accordance with the applicable requirements of 3.5.3 of the Rules.

Appendix 1-1 Guidelines for Calculation of the Attained EEDI for Sea-going Ships Engaged on International Voyages

1 These Guidelines apply only to calculation of the Attained EEDI for ships engaged on international voyages applying for CDx class notations as defined in 2.3.2 of the Rules. For sea-going ships engaged on domestic voyages, Attained EEDI is to be calculated according to Appendix 1-2.

2 Attained EEDI calculation formula

The Attained EEDI means the attained ship Energy Efficiency Design Index, which is a measure of ship energy efficiency (g/t-nmile) and calculated by the following formula:

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

* If part of the normal maximum sea load is provided by shaft generators, for that part of the power, SFC_{ME} and C_{FME} may be used instead of SFC_{AE} and C_{FAE} .

When $0.75 * \sum_{i=1}^{nPTO} P_{PTO(i)} \leq P_{AE}$, $P_{AE} \cdot C_{FAE} \cdot SFC_{AE}$ may be replaced by:

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

When $0.75 * \sum_{i=1}^{nPTO} P_{PTO(i)} > P_{AE}$, $P_{AE} \cdot C_{FAE} \cdot SFC_{AE}$ may be replaced by:

$$P_{AE} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$$

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

3 Definition and selection of parameters in Attained EEDI calculation formula

3.1 Carbon conversion factor (C_F)

C_F is a non-dimensional conversion factor between fuel consumption and CO₂ emission based on carbon content, measured int-CO₂/t-Fuel. The subscripts MEi and AEi refer to the main and auxiliary engine(s) respectively. C_F is the carbon conversion factor corresponds to the fuel used when determining SFC listed in the applicable test report included in a Technical File as defined in NO_x Technical Code (hereinafter referred to as “test report included in a NO_x technical file”). The value of C_F is shown in Table 3.1:

Carbon Conversion Factor C_F

Table 3.1

Type of fuel	Reference	Lower calorific value (kJ/kg)	Carbon content	C_F (t-CO ₂ /t-Fuel)
1. Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	42,700	0.8744	3.206
2. Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41,200	0.8594	3.151
3. Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40,200	0.8493	3.114
4. Liquefied Petroleum Gas (LPG)	Propane	46,300	0.8182	3.000
	Butane	45,700	0.8264	3.030
5. Liquefied Natural Gas (LNG)		48,000	0.7500	2.750
6. Methanol		19,900	0.3750	1.375
7. Ethanol		26,800	0.5217	1.913

In case of a ship equipped with a dual-fuel main or auxiliary engine, the C_F -factor for gas fuel and the C_F -factor for fuel oil are to apply and be multiplied with the specific fuel consumption of each fuel at the relevant EEDI load point. Meanwhile, gas fuel is to be identified whether it is regarded as the “primary fuel” in accordance with the formula below:

$$f_{DFgas} = \frac{\sum_{i=1}^{ntotal} P_{total(i)}}{\sum_{i=1}^{ngasfuel} P_{gasfuel(i)}} \times \frac{V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}{\left(\sum_{i=1}^{nliquid} V_{liquid(i)} \times \rho_{liquid(i)} \times LCV_{liquid(i)} \times K_{liquid(i)} \right) + V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}$$

$$f_{DFliquid} = 1 - f_{DFgas}$$

where : f_{DFgas} – the fuel availability ratio of gas fuel corrected for the power ratio of gas engines to total engines, f_{DFgas} is not to be greater than 1;

V_{gas} – the total net gas fuel capacity on board in m³. If other arrangements, like exchangeable (specialized) LNG tank-containers and/or arrangements allowing frequent gas refueling are used, the capacity of the whole LNG fuelling system is to be used for V_{gas} . The boil-off rate (BOR) of gas cargo tanks can be calculated and included to V_{gas} if it is connected to the fuel gas supply system (FGSS);

V_{liquid} – the total net liquid fuel capacity on board in m³ of liquid fuel tanks permanently connected to the ship’s fuel system. If one fuel tank is disconnected by permanent sealing valves, V_{liquid} of the fuel tank can be ignored;

ρ_{gas} – the density of gas fuel in kg/m³;

ρ_{liquid} – the density of each liquid fuel in kg/m³;

LCV_{gas} – the low calorific value of gas fuel in kJ/kg;

LCV_{liquid} – the low calorific value of liquid fuel in kJ/kg;

K_{gas} – the filling rate for gas fuel tanks;

K_{liquid} – the filling rate for liquid fuel tanks;

P_{total} – the total installed engine power, P_{ME} and P_{AE} in kW;

$P_{gasfuel}$ – the dual fuel engine installed power, P_{ME} and P_{AE} in kW;

- .1 If the total gas capacity is at least 50% of the fuel capacity dedicated to the dual fuel engines, namely $f_{DFgas} \geq 0.5$, then gas fuel is regarded as the “primary fuel”, and $f_{DFgas} = 1$ and $f_{DFliquid} = 0$ for each dual fuel engine.
- .2 If $f_{DFgas} < 0.5$, gas fuel is not regarded as the “primary fuel”. The C_F and SFC in the EEDI calculation for each dual fuel engine (both main and auxiliary engines) are to be calculated as the weighted average of C_F and SFC for gas and liquid mode, according to f_{DFgas} and $f_{DFliquid}$, such as the original item of $P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$ in the EEDI calculation is to be replaced by the formula below:

$$P_{ME(i)} \cdot (f_{DFgas(i)} \cdot (C_{FME\ pilot\ fuel(i)} \cdot SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} \cdot SFC_{ME\ gas(i)}) + f_{DFliquid(i)} \cdot C_{FME\ liquid(i)} \cdot SFC_{ME\ liquid(i)})$$

3.2 Ship speed (V_{ref})

V_{ref} is the ship speed, measured in knot, on deep water in the condition corresponding to the Capacity as defined in paragraph 3.3 (in case of passenger ships and cruise passenger ships, this condition is to be summer load draught as provided in paragraph 3.4) at the shaft power of the engine(s) as defined in paragraph 3.5 and assuming the weather is calm with no wind and no waves.

3.3 Capacity

Capacity is defined differently for different ship types:

3.3.1 For bulk carriers, tankers, gas carriers, LNG carriers, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships, ro-ro passenger ships, refrigerated cargo carriers, general cargo ships and combination carriers, deadweight is to be used as capacity.

3.3.2 For passenger ships and cruise passenger ships, gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, annex I, regulation 3, is to be used as capacity.

3.3.3 For container ships, 70% of the deadweight (*DWT*) is to be used as capacity. EEDI values for container ships are calculated as follows:

- (1) Attained EEDI value is to be calculated using 70% *DWT* in accordance with EEDI formula;
- (2) Required EEDI value is to be calculated using 100% *DWT* in accordance with reference line formula in 2.3.2 of the Rules.

3.4 Deadweight (*DWT*)

Deadweight 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 is to be taken as the maximum summer draught as certified in the stability booklet approved by the Administration or CCS.

3.5 Power (*P*)

P is the power of the main and auxiliary engines, measured in kW. The subscripts *ME* and *AE* refer to the main and auxiliary engine(s) respectively. The summation on *i* is for all engines with the number of engines (*nME*). Power related parameters involved in EEDI calculation formula are as follows:

3.5.1 $P_{ME(i)}$ is 75% of the rated installed power (*MCR*) for each main engine. The *MCR* value specified on the EIAPP certificate is to be used for calculation. If the main engines are not required to have an EIAPP certificate, the *MCR* value on the nameplate is to be used for calculation.

For LNG carriers having diesel electric propulsion system, $P_{ME(i)}$ is to be calculated by the following formula:

$$P_{ME(i)} = 0.83 \times \frac{MPP_{Motor(i)}}{\eta_{(i)}}$$

where: $MPP_{Motor(i)}$ is the rated output of motor specified in the certified document.

$\eta_{(i)}$ is to be taken as the product of electrical efficiency of generator, transformer, converter, and motor, taking into consideration the weighted average as necessary. The electrical efficiency, $\eta_{(i)}$, is to be taken as 91.3% for the purpose of calculating attained EEDI. Alternatively, if the value more than 91.3% is to be applied, the $\eta_{(i)}$ is to be obtained by measurement and verified by method approved by CCS.

For LNG carriers having steam turbine propulsion systems, $P_{ME(i)}$ is 83% of the rated installed power ($MCR_{SteamTurbine}$) for each steam turbine_(i).

3.5.2 $P_{PTO(i)}$ — In case where a shaft generator is installed, the shaft generator power ($P_{PTO(i)}$) is 75% of the rated electrical power output for each shaft generator. In case that shaft generator(s) are installed to steam turbine, $P_{PTO(i)}$ is 83% of the rated electrical output power and the factor of 0.75 is to be replaced to 0.83.

There are two options to calculate the effect of shaft generators:

(1) Option 1: The maximum allowable deduction for the calculation of $\sum P_{ME(i)}$ is to be no more than P_{AE} as defined in paragraph 3.5.4. For this case, $\sum P_{ME(i)}$ is calculated as:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 \times (\sum MCR_{ME(i)} - \sum P_{PTO(i)}) \text{ with } 0.75 \times \sum P_{PTO(i)} \leq P_{AE} ; \text{ or}$$

(2) Option 2: Where an engine is installed with a higher rated power output than that which the propulsion system is limited to as verified by technical means, the value of $\sum P_{ME(i)}$ is to be 75% of that limited power for determining the reference speed V_{ref} defined in 3.2 and for EEDI calculation.

Figure 3.5.2 gives guidance for determination of $\sum P_{ME(i)}$.

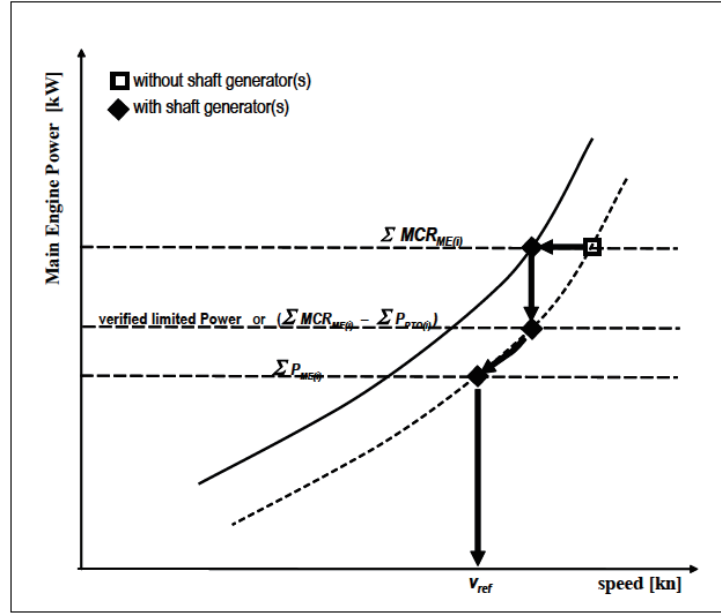


Figure 3.5.2 Determination of the Power $\sum P_{ME(i)}$ of a Main Engine

3.5.3 $P_{PTI(i)}$ —In case where shaft motor(s) are installed, $P_{PTI(i)}$ is 75% of the rated power consumption of each shaft motor divided by the weighted average efficiency of the generator(s), as follows:

$$\sum P_{PTI(i)} = \frac{\sum (0.75 \cdot P_{SM,max(i)})}{\eta_{Gen}}$$

where: $P_{SM,max(i)}$ — is the rated power consumption of each shaft motor;

η_{Gen} — is the weighted average efficiency of the generator(s).

In case that shaft motor(s) are installed to steam turbine, $P_{PTI(i)}$ is 83% of the rated power consumption and the factor of 0.75 is to be replaced to 0.83.

The propulsion power at which V_{ref} is measured, is:

$$\sum P_{ME(i)} + \sum P_{PTI(i),shaft}$$

where: $\sum P_{PTI(i),shaft} = \sum (0.75 \cdot P_{SM,max(i)} \cdot \eta_{PTI(i)})$;

$\eta_{PTI(i)}$ — is the efficiency of each shaft motor installed.

Where the total propulsion power as defined above is higher than 75% of the power the propulsion system is limited to by verified technical means, then 75% of the limited power is to be used as the total propulsion power for determining the reference speed, V_{ref} as defined in 3.2 and for EEDI calculation. Then, $(\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} + \sum_{i=1}^{n_{PTI}} P_{PTI(i)} \cdot C_{FAE} \cdot SFC_{AE})$ is to be replaced by 75% of the limited power multiplied by the weighted average value of $(SFC_{ME} \cdot C_{FME})$ and $(SFC_{AE} \cdot C_{FAE})$.

In case of combined PTI/PTO , the normal operational mode at sea will determine which of these is to be used in the EEDI calculation. For example, if this combined system is used as a shaft generator for ships in normal operation at sea, the P_{PTO} parameter is to be used in the EEDI calculation formula and P_{PTI} equals 0.

The shaft motor's chain efficiency may be taken into consideration to account for the energy losses in the equipment from the switchboard to the shaft motor, if the chain efficiency of the shaft motor is given in a verified document.

3.5.4 P_{AE} is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery/systems and accommodation, e.g. main engine pumps, navigational systems and equipment and living on board, but excluding the power not for propulsion machinery/systems, e.g. thrusters, cargo pumps, cargo gear, ballast pumps, reefers and cargo hold fans for maintaining cargo, in the condition where the ship engaged in voyage at the speed V_{ref} under the condition as mentioned in paragraph 3.2.

P_{AE} used for the calculation of Attained EEDI of ships is to be calculated by the following experience-based formulae instead of the actual auxiliary engine power.

(1) For ships with a total propulsion power $(\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75})$ of 10,000 kW or above, P_{AE} is defined as:

$$P_{AE} (\sum MCR_{ME(i)} \geq 10000 \text{ kW}) = \left(0.025 \times \left(\sum_{i=1}^{n_{ME}} MCR_{ME(i)} + \frac{\sum_{i=1}^{n_{PTI}} P_{PTI(i)}}{0.75} \right) \right) + 250$$

(2) For ships with a total propulsion power $(\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75})$ below 10,000 kW, P_{AE} is defined as:

$$P_{AE} (\sum MCR_{ME(i)} < 10000 \text{ kW}) = 0.05 \times \left(\sum_{i=1}^{n_{ME}} MCR_{ME(i)} + \frac{\sum_{i=1}^{n_{PTI}} P_{PTI(i)}}{0.75} \right)$$

(3) For LNG carriers with a reliquefaction system or compressor(s), designed to be used in normal operation and essential to maintain the LNG cargo tank pressure below the maximum allowable relief valve setting of a cargo tank in normal operation, the following terms are to be added to above P_{AE} formula in accordance with 1, 2 or 3 as below:

① For ships having re-liquefaction system:

$$+ \text{CargoTankCapacity}_{\text{LNG}} \times BOR \times COP_{\text{reliquefy}} \times R_{\text{reliquefy}}$$

where: $\text{CargoTankCapacity}_{\text{LNG}}$ — the LNG Cargo Tank Capacity, in m^3 .

BOR — the design rate of boil-off gas of entire ship per day, which is specified in the specification of the building contract.

$COP_{\text{reliquefy}}$ — the coefficient of design power performance for reliquefying boil-off gas per unit volume, as follows:

$$COP_{\text{reliquefy}} = \frac{425(\text{kg/m}^3) \times 511(\text{kJ/kg})}{24(\text{h}) \times 3600(\text{sec}) \times COP_{\text{cooling}}}$$

$COP_{cooling}$ — the coefficient of design performance of reliquefaction and 0.166 is to be used. Another value calculated by the manufacturer and verified by the Administration or CCS may be used.

$R_{reliquefy}$ — the ratio of boil-off gas (BOG) to be re-liquefied to entire BOG, calculated as follows:

$$R_{reliquefy} = \frac{BOG_{reliquefy}}{BOG_{total}}$$

- ② For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying high-pressured gas derived from boil-off gas to the installed engines (typically intended for 2-stroke dual fuel engines):

$$+COP_{comp} \times \sum_{i=1}^{nME} SFC_{ME(i), gasmode} \times \frac{P_{ME(i)}}{1000}$$

where: COP_{comp} is the design power performance of compressor and 0.33 (kWh/kg) is to be used. Another value calculated by the manufacturer and verified by the Administration or an organization recognized by the Administration may be used.

- ③ For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying low-pressured gas derived from boil-off gas to the installed engines (typically intended for 4-stroke dual fuel engines):

$$+0.02 \times \sum_{i=1}^{nME} P_{ME(i)}$$

With regard to the factor of 0.02, it is assumed that the additional energy needed to compress BOG for supplying to a 4-stroke dual fuel engine is approximately equal to 2% of P_{ME} , compared to the energy needed to compress BOG for supplying to a steam turbine.

For LNG carriers having diesel electric propulsion system, $MPP_{Motor(i)}$ is to be used instead $MCR_{ME(i)}$ for P_{AE} calculation.

For LNG carriers having steam turbine propulsion system and of which electric power is primarily supplied by turbine generator closely integrated into the steam and feed water systems, P_{AE} may be treated as 0 instead of taking into account electric load in calculating $SFC_{SteamTurbine}$.

- (4) For ship where the P_{AE} value calculated by (1), (2) or (3) above is significantly different from the total power used at the speed V_{ref} , e.g., in cases of passenger ships, ro-ro passenger ships and cruise passenger ships, the P_{AE} value is to be estimated by the consumed electric power (excluding propulsion) in conditions when the ship is engaged in a voyage at the reference speed (V_{ref}) as given in the electric power table, divided by the average efficiency of the generator(s) weighted by power. As an option for other vessel types, if the difference between P_{AE} value calculated by (1), (2) or (3) above and P_{AE} based on electric power table, leads to a variation of the computed EEDI value exceeding 1%, the value for auxiliary power could be taken from the electric power table.

The electric power table for EEDI calculation is to be examined and validated by CCS. Where ambient conditions affect any electrical load in the power table, the contractual ambient conditions leading to the maximum design electrical load of the installed system for the ship in general are to apply. See appendix 2 for the development of electric power tables.

3.5.5 $P_{eff(i)}$ is the output of the innovative mechanical energy efficient technology for propulsion at 75% main engine power.

Mechanical recovered waste energy directly coupled to shafts need not be measured, since the effect of the technology is directly reflected in the V_{ref} .

In case of a ship equipped with a number of engines, the C_F and SFC are to be the power weighted average value of all the main engines.

In case of a ship equipped with a dual-fuel engine, the C_F and SFC are to be obtained according to 3.1 and 3.7.

3.5.6 $P_{AEeff(i)}$ is the auxiliary power reduction due to innovative electrical energy efficient technology measured at $P_{ME(i)}$.

3.5.7 Figure 3.5.7(1) and 3.5.7(2) illustrate a generic marine power plant and the power used for EEDI calculation.

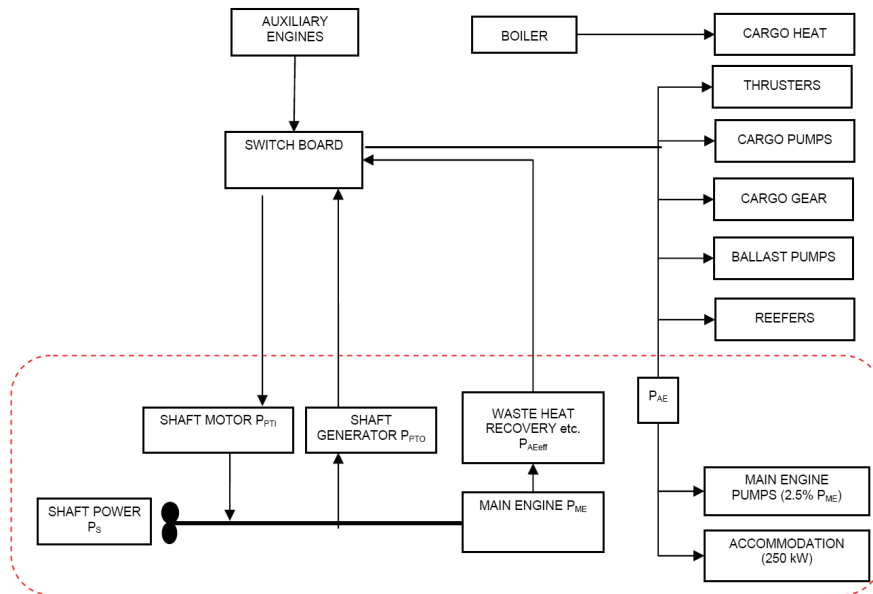


Figure 3.5.7(1) A Generic Marine Power Plant for Ships Having Conventional Propulsion

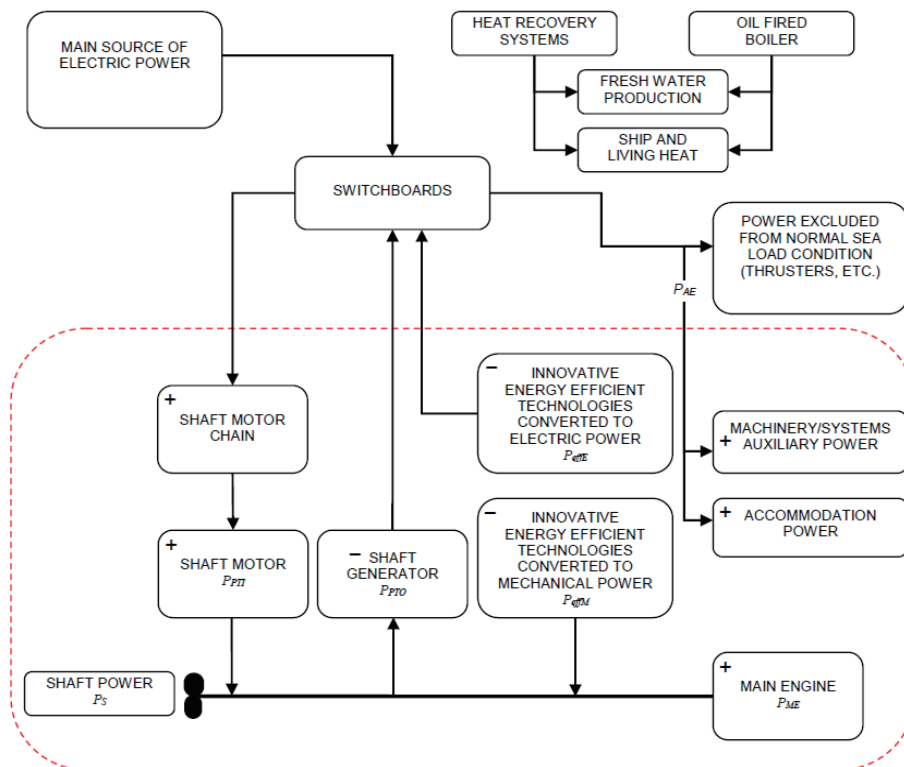


Figure 3.5.7(2) A Generic Marine Power Plant for a Cruise Passenger Ships Having Non-conventional Propulsion

3.6 The essential parameters V_{ref} , Capacity and P for determining EEDI for a ship are interrelated and should be consistent with each other. As for LNG carriers having diesel electric or steam turbine propulsion systems, V_{ref} is the relevant speed at 83% of MPP_{Motor} or $MCR_{SteamTurbine}$ respectively.

3.7 Specific Fuel Consumption (SFC)

SFC is the certified specific fuel consumption, measured in g/kWh, of the engines or steam turbines. SFC_{ME} and SFC_{AE} refer to the specific fuel consumption of the main and auxiliary engine(s) respectively.

3.7.1 For engines certified to the E2 or E3 duty cycles of the NO_x Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{ME(i)}$) is that recorded in the test report included in a NO_x technical file for the engine(s) at 75% of MCR power or its torque rating.

3.7.2 For engines certified to the D2 or C1 duty cycles of the NO_x Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{AE(i)}$) is that recorded in the test report included in a NO_x technical file at the engine(s) at 50% of MCR power or its torque rating.

3.7.3 If gas fuel is used as primary fuel in accordance with paragraph 2.3.3 of CCS *Guidelines for Verification of the Energy Efficiency Design Index (EEDI) of Ships*, SFC in gas mode is to be used. In case that installed engine(s) have no approved NO_x Technical File tested in gas mode, the SFC of gas mode is to be submitted by the manufacturer and confirmed by CCS.

3.7.4 The SFC is to be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil (42,700 kJ/kg), referring to ISO 15550:2002 and ISO 3046-1:2002.

3.7.5 For ships where the P_{AE} value calculated by 3.5.4.(1) or (2) above is significantly different from the total power used at normal seagoing, e.g., conventional passenger ships, the Specific Fuel Consumption (SFC_{AE}) of the auxiliary generators is that recorded in the test report included in a NO_x technical file for the engine(s) at 75% of MCR power or its torque rating.

3.7.6 SFC_{AE} is the power-weighted average among $SFC_{AE(i)}$ of the respective engines i.

3.7.7 For those engines which do not have EIAPP certificates because its power is below 130 kW, the SFC specified by the manufacturer and endorsed by the Administration or CCS is to be used.

3.7.8 At the design stage, in case of unavailability of a test report in the NO_x file, the SFC specified by the manufacturer and endorsed by the Administration or CCS is to be used.

3.7.9 For LNG-driven engines, SFC measured in kJ/kWh is to be amended to SFC value measured in g/kWh by using the standard lower heat value of the LNG (48,000 kJ/kg) (Refer to 2006 IPCC Guidelines).

3.7.10 The $SFC_{SteamTurbine}$ is to be calculated by manufacturer and verified by the Administration or CCS as follows:

$$SFC_{SteamTurbine} = \frac{\text{FuelConsumption}}{\sum_{ME(i)}^{nME}}$$

where:

(1) *Fuel consumption* is fuel consumption of boiler per hour (g/h). For ships of which electric power is primarily supplied by Turbine Generator closely integrated into the steam and feed water systems, not only P_{ME} but also electric loads corresponding to paragraph 3.5.4 are to be taken into account.

(2) The SFC is to be corrected to the value of LNG using the standard lower calorific value of the LNG (48,000 kJ/kg) at SNAME Condition (condition standard; air temperature 24°C, inlet temperature of fan 38°C, sea water temperature 24°C).

(3) In this correction, the difference of the boiler efficiency based on lower calorific value between test fuel and LNG is to be taken into account.

3.7.11 Reference lower calorific values of additional fuels are given in the Table 3.1 of these Guidelines. The reference lower calorific value corresponding to the conversion factor of the respective fuel is to be used for calculation.

3.8 Correction factor f_j

f_j is a correction factor to account for ship specific design elements.

3.8.1 For ice-classed ships, the power of the main engine is to be increased due to navigation in ice. Therefore an additional correction factor is applied to compensate for negative effects caused by the increased power on EEDI of such ships. This factor is to be taken as the greater value of f_{j0} and $f_{j,min}$ as tabulated in Table 3.8.1, but not to be greater than 1.0.

Correction factor for power f_j for ice-classed ships **Table 3.8.1**

Ship type	f_{j0}	$f_{j,min}$ depending on the ice class			
		IA Super	IA	IB	IC
Tanker	$\frac{17.444 \cdot DWT^{0.5766}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.2488 \cdot DWT^{0.0903}$	$0.4541 \cdot DWT^{0.0524}$	$0.7783 \cdot DWT^{0.0145}$	$0.8741 \cdot DWT^{0.0079}$
Bulk carrier	$\frac{17.207 \cdot DWT^{0.5705}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.2515 \cdot DWT^{0.0851}$	$0.3918 \cdot DWT^{0.0556}$	$0.8075 \cdot DWT^{0.0071}$	$0.8573 \cdot DWT^{0.0087}$
General cargo ship	$\frac{1.974 \cdot DWT^{0.7987}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.1381 \cdot DWT^{0.1435}$	$0.1574 \cdot DWT^{0.144}$	$0.3256 \cdot DWT^{0.0922}$	$0.4966 \cdot DWT^{0.0583}$
Refrigerated cargo ship	$\frac{5.598 \cdot DWT^{0.696}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.5254 \cdot DWT^{0.0357}$	$0.6325 \cdot DWT^{0.0278}$	$0.7670 \cdot DWT^{0.0159}$	$0.8918 \cdot DWT^{0.0079}$

Alternatively, if an ice-class ship is designed and constructed based on an open water ship with same shape and size of hull with EEDI certification, the power correction factor, f_j , for ice-classed ships can be calculated by using propulsion power of the new ice-class ship required by ice-class regulations, $P_{ice\ class}$, and the existing open water ship, P_{ow} , as follows:

$$f_j = \frac{P_{ow}}{P_{ice\ class}}$$

In this case, V_{ref} should be measured at the shaft power of the engine(s) installed on the existing open water ship as defined in paragraph 3.5.

3.8.2 The power correction factor f_j , for shuttle tankers with propulsion redundancy is to be $f_j = 0.77$. This correction factor applies to above-mentioned shuttle tankers with propulsion redundancy and having a deadweight of 80,000 ~ 160,000 tonnes. The shuttle tankers with propulsion redundancy are tankers used for loading of crude oil from offshore installations and equipped with dual-engine and twin-propellers, need to meet the requirements for dynamic positioning and redundancy propulsion class notation.

3.8.3 For ro-ro cargo and ro-ro passenger ships f_{jRoRo} is calculated as follows:

$$f_{jRoRo} = \frac{1}{F_{nL}^a \times \left(\frac{L_{pp}}{B_s}\right)^\beta \cdot \left(\frac{B_s}{d_s}\right)^\gamma \cdot \left(\frac{L_{pp}}{\nabla^{1/3}}\right)^\delta}; \text{ if } f_{jRoRo} > 1, \text{ then } f_j = 1$$

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

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

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

3.8.4 The factor f_j for general cargo ships is calculated as follows:

$$f_j = \frac{0.174}{Fn_{\nabla}^{2.3} \cdot C_b^{0.3}}; \text{ if } f_j > 1, \text{ then } f_j = 1$$

where:

$$Fn_{\nabla} = \frac{0.5144 \cdot V_{ref}}{\sqrt{g \cdot \nabla^{\frac{1}{3}}}}; \text{ if } Fn_{\nabla} > 0.6, \text{ then } Fn_{\nabla} = 0.6$$

$$C_b = \frac{\nabla}{L_{pp} \cdot B_s \cdot d_s}$$

3.8.5 For other ship types not included in the above table, f_j is to be taken as 1.0.

3.9 Correction factor f_i

f_i is the capacity correction factor for any technical/regulatory limitation on capacity, which is used to compensate for negative effects on EEDI due to the loss of capacity, and can be assumed 1.0 if no necessity of the factor is granted.

3.9.1 For ice-classed ships, the capacity is decreased due to the increased ship weight resulting from the increased steel plate thickness for guaranteeing their ice breaking capability. Therefore this capacity correction factor is applied to compensate for the loss of capacity. The capacity correction factor, f_i , for ice-classed ships having DWT as the measure of capacity should be calculated as follows:

$$f_i = f_{i(iceclass)} \cdot f_{iC_b}$$

where $f_{i(iceclass)}$ is the capacity correction factor for ice-strengthening of the ship, which can be obtained from Table 3.9.1(1) and f_{iC_b} is the capacity correction factor for improved ice-going capability, which should not be less than 1.0 and which should be calculated as follows:

$$f_{iC_b} = \frac{C_{reference\ design}}{C_b},$$

where $C_{reference\ design}$ is the average block coefficient for the ship type, which can be obtained from Table 3.9.1(2) for bulk carriers, tankers and general cargo ships, and C_b is the block coefficient of the ship. For ship types other than bulk carriers, tankers and general cargo ships, $f_{iC_b} = 1.0$.

Capacity correction factor for ice-strengthening of the hull

Table 3.9.1(1)

Ice class ⁷	$f_{i(iceclass)}$
IC	$f_{i(IC)} = 1.0041 + 58.5/DWT$
IB	$f_{i(IB)} = 1.0067 + 62.7/DWT$
IA	$f_{i(IA)} = 1.0099 + 95.1/DWT$
IA Super	$f_{i(IAS)} = 1.0151 + 228.7/DWT$

Average block coefficients $C_{\text{reference design}}$ for bulk carriers, tankers and general cargo ships Table 3.9.1(2)

Ship type	Size categories				
	below 10,000 DWT	10,000~25,000 DWT	25,000~55,000 DWT	55,000~75,000 DWT	above 75,000 DWT
Bulk carrier	0.78	0.80	0.82	0.86	0.86
Tanker	0.78	0.78	0.80	0.83	0.83
General cargo ship	0.80				

Alternatively, the capacity correction factor for ice-strengthening of the ship ($f_{i(\text{iceclass})}$) can be calculated by using the formula given for the ship specific voluntary enhancement correction coefficient (f_{iVSE}) in paragraph 3.9.2. This formula can also be used for other ice classes than those given in Table 3.9.1(1).

3.9.2 For ships with voluntary structural enhancements, f_{iVSE} is to be expressed as follows:

$$f_{iVSE} = \frac{DWT_{\text{reference design}}}{DWT_{\text{enhanced design}}}$$

where: $DWT_{\text{reference design}} = \Delta_{\text{ship}} - \text{lightweight}_{\text{reference design}}$;

$$DWT_{\text{enhanced design}} = \Delta_{\text{ship}} - \text{lightweight}_{\text{enhanced design}}.$$

For this calculation, the same displacement (Δ) is to be taken for reference and enhanced designs.

Note: Structural and/or additional class notations such as, but not limited to, “strengthened for discharge with grabs” and “strengthened bottom for loading/unloading aground”, which result in a loss of deadweight of the ship, are also seen as examples of “voluntary structural enhancements”.

(1) DWT before enhancements ($DWT_{\text{reference design}}$) is the deadweight prior to application of the structural enhancements. DWT after enhancements ($DWT_{\text{enhanced design}}$) is the deadweight following the application of voluntary structural enhancements.

(2) A change of material (e.g. from aluminum alloy to steel) or a change in grade of the same material (e.g. in steel types, grades, properties and conditions) between reference design and voluntarily enhanced design is not to be allowed for the f_{iVSE} calculation.

(3) Two sets of structural plans of the ship (one set for the reference design and the other set for the enhanced design) are to be submitted to CCS for assessment. As an alternative, only one set of structural plans of the reference design with annotations of voluntary structural enhancements may be submitted. Both sets of structural plans are to comply with the applicable regulations for the ship type and intended trade.

3.9.3 For bulk carriers and oil tankers which are constructed according to Common Structural Rules (CSR) and assigned the CSR notation, the following capacity correction factor f_{iCSR} is to be used:

$$f_{iCSR} = 1 + (0.08 \times \frac{LWT_{CSR}}{DWT_{CSR}})$$

where: DWT_{CSR} is ship’s deadweight;

LWT_{CSR} is ship’s lightweight.

3.9.4 For other ship types not included in the table above, f_i is to be taken as 1.0.

3.9.5 The above factor f_i may be accumulated (multiplied).

3.10 Cubic capacity correction factor f_c

f_c is the cubic capacity correction factor and is to be taken as 1.0 if no necessity of the factor is granted. It is calculated as follows:

3.10.1 For chemical tankers, the cubic capacity correction factor f_c is to be:

$$f_c = R^{(-0.7)} - 0.014 \quad \text{for } R < 0.98; \text{ or}$$
$$f_c = 1.00 \quad \text{for } R \geq 0.98$$

where: R is the ratio of the ship's DWT (in tonnes) to the total cubic capacity (in m^3) of its cargo tanks (m^3).

3.10.2 For gas carriers which are constructed or adapted to carry liquefied natural gas in bulk and with propulsion systems directly driven by diesel engines, the capacity correction factor f_{cLNG} is to be:

$$f_{cLNG} = R^{-0.56}$$

where: R is the ratio of the ship's DWT (in tonnes) to the total cubic capacity (in m^3) of its cargo tanks.

Note: This factor is applicable to LNG carriers defined as gas carriers in regulation 2.26 of MARPOL Annex VI (LNG carriers before 1 September 2015) and is not to be applied to LNG carriers defined in regulation 2.38 of MARPOL Annex VI.

3.10.3 For ro-ro passenger ships having a DWT/GT -ratio of less than 0.25, the following cubic capacity correction factor, f_{cRoPax} is to apply:

$$f_{cRoPax} = 1 + \left(\frac{(DWT/GT)}{0.25} \right)^{-0.8}$$

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.

3.10.4 For bulk carriers having R of less than 0.55 (e.g. wood chip carriers), the following cubic capacity correction factor, $f_{c \text{ bulk carriers designed to carry light cargoes}}$, is to apply:

$$f_{c \text{ bulk carriers designed to carry light cargoes}} = R^{-0.15}$$

where: R — the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 3.4 divided by the total cubic capacity of the cargo holds of the ship (m^3).

3.11 Correction factor f_w

f_w is a non-dimensional coefficient indicating the decrease of speed in representative sea conditions of wave height, wave frequency and wind speed (e.g., Beaufort Scale 6).

3.11.1 f_w is to be taken as 1.0 in calculation of the Attained EEDI specified in 2.3.3 of Chapter 2.

3.11.2 Where the Owner requests on a voluntary basis the application of f_w , the Attained EEDI value using f_w is to be referred to Attained $EEDI_{weather}$ and confirmed by CCS, and indicated in the related certificate. f_w is to be determined as follows:

(1) f_w can be determined by conducting the ship-specific simulation of its performance at representative sea conditions. The simulation methodology is to be that as prescribed in the Guidelines developed by IMO and the method and outcome for an individual ship is to be verified by the Administration or CCS.

(2) In case where the simulation is not conducted, f_w value is to be taken from the “Standard f_w ” table/curve prescribed in the Guidelines developed by IMO.

Refer to Interim Guidelines for the calculation of the coefficient f_w for decrease in ship speed in a representative sea condition for trial use, approved by the Organization and circulated by MEPC.1/Circ.796.

3.11.3 f_w and Attained $EEDI_{weather}$ together with the representative sea conditions are to be indicated in the EEDI technical file to make a distinction from Attained EEDI required in 2.3.3 of Chapter 2.

3.12 Energy efficiency factor f_{eff}

f_{eff} is the availability factor of each innovative energy efficiency technology. f_{eff} for waste energy recovery system is to be taken as 1.0.

3.13 Length between perpendiculars (L_{pp})

L_{pp} means 96% of the total length on a waterline at 85% of the least moulded depth measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, if that were greater. For ships designed with a rake of keel, the waterline on which this length is measured is to be parallel to the designed waterline. L_{pp} is to be measured in m.

3.14 Correction factor f_i

f_i is the factor for general cargo ships equipped with cranes and other cargo-related gear to compensate in a loss of deadweight of the ship.

$$f_i = f_{cranes} f_{sideloader} f_{ro-ro}$$

where: $f_{cranes} = 1$ if no cranes are present;
 $f_{sideloader} = 1$ if no side loaders are present;
 $f_{ro-ro} = 1$ if no ro-ro ramp is present.

3.14.1 Definition of f_{cranes} :

$$f_{cranes} = 1 + \frac{\sum_{n=1}^n (0.0519 \cdot SWL_n \cdot Reach_n + 32.11)}{Capacity}$$

where: SWL — Safe Working Load, as specified by crane manufacturer in t;
 $Reach$ — Reach at which the Safe Working Load can be applied in m;
 n — Number of cranes.

3.14.2 For other cargo gear such as side loaders and ro-ro ramps, the factor is to be defined as follows:

$$f_{sideloader} = \frac{Capacity_{No\ sideloaders}}{Capacity_{sideloaders}}$$

$$f_{RoRo} = \frac{Capacity_{No\ RoRo}}{Capacity_{RoRo}}$$

The weight of the side loaders and ro-ro ramps is to be based on a direct calculation, in analogy to the calculations as made for factor f_{VSE} .

3.15 Summer load line draught, d_s

d_s is the vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to the summer freeboard draught to be assigned to the ship.

3.16 Breadth, B_s

B_s is the greatest moulded breadth of the ship, in metres, at or below the load line draught, d_s .

3.17 Volumetric displacement, ∇

∇ in cubic metres (m^3), is the volume of the moulded displacement of the ship, excluding appendages, in a ship with a metal shell, and is the volume of displacement to the outer surface of the hull in a ship with a shell of any other material, both taken at the summer load line draught, d_s , as stated in the approved stability booklet/loading manual.

3.18 Gravitational acceleration g

g is the gravitational acceleration, 9.81m/s^2 .

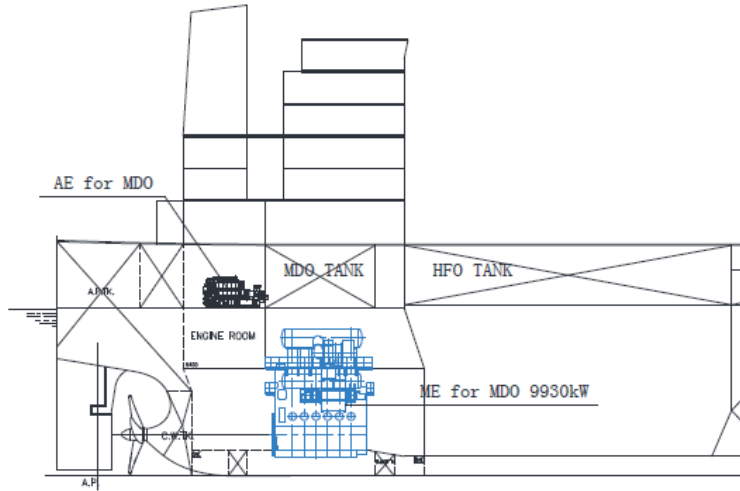
3.19 Factor for ice-classed ships having IA Super and IA, f_m

For ice-classed ships having IA Super or IA, the following factor, f_m , should apply:

$$f_m = 1.05$$

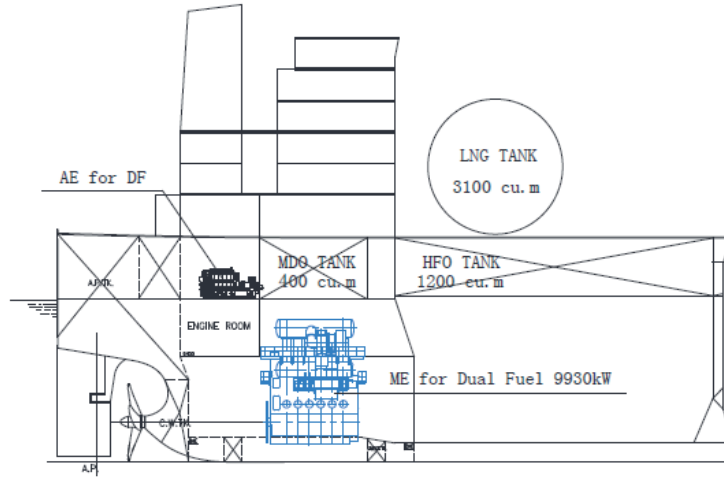
Annex EEDI Calculation Examples for Use of Dual Fuel Engines

Case 1: Standard Kamsarmax ship, one main engine (MDO), standard auxiliary engines (MDO), no shaft generator:



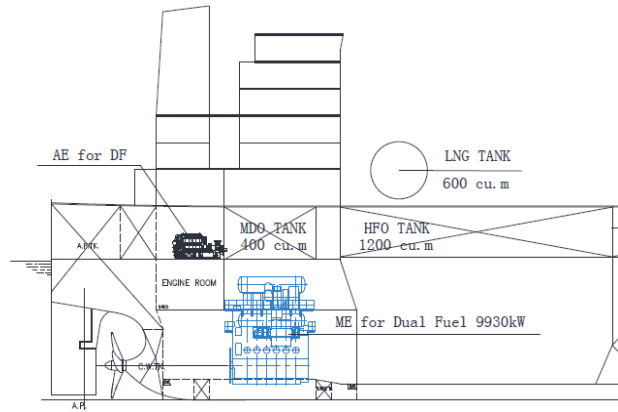
S/N	Parameter	Formula or source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	$Capacity$	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	$0.75 \times MCR_{ME}$	kW	7447.5
5	P_{AE}	$0.05 \times MCR_{ME}$	kW	496.5
6	C_{FME}	C_F factor of main engine using MDO	-	3.206
7	C_{FAE}	C_F factor of auxiliary engine using MDO	-	3.206
8	SFC_{ME}	Specific fuel consumption of ME at P_{ME}	g/kWh	165
9	SFC_{AE}	Specific fuel consumption of AE at P_{AE}	g/kWh	210
10	$EEDI$	$[(P_{ME} \times C_{FME} \times SFC_{ME}) + (P_{AE} \times C_{FAE} \times SFC_{AE})] / (V_{ref} \times Capacity)$	gCO ₂ /tnm	3.76

Case 2: LNG is regarded as the “primary fuel” if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with bigger LNG tanks.



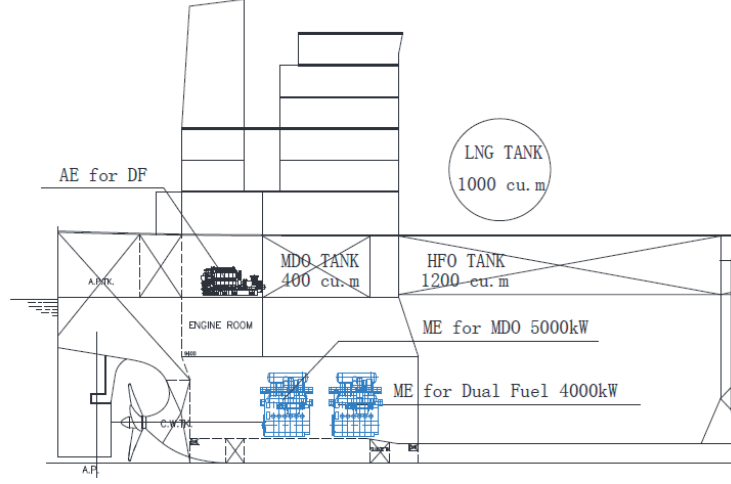
S/N	Parameter	Formula or source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	$Capacity$	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	$0.75 \times MCR_{ME}$	kW	7447.5
5	P_{AE}	$0.05 \times MCR_{ME}$	kW	496.5
6	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$C_{FAEPilotfuel}$	C_F factor of pilot fuel for auxiliary engine using MDO	-	3.206
8	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
10	$SFC_{AEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
11	$SFC_{ME LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
12	$SFC_{AE LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
13	V_{LNG}	LNG tank capacity on board	m ³	3100
14	V_{HFO}	Heavy fuel oil tank capacity on board	m ³	1200
15	V_{MDO}	Marine diesel oil tank capacity on board	m ³	400
16	ρ_{LNG}	Density of LNG	kg/m ³	450
17	ρ_{HFO}	Density of heavy fuel oil	kg/m ³	991
18	ρ_{MDO}	Density of marine diesel oil	kg/m ³	900
19	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
20	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
21	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
22	K_{LNG}	Filling rate of LNG tank	-	0.95
23	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
24	K_{MDO}	Filling rate of marine diesel tank	-	0.98
25	f_{DFgas}	$\frac{P_{ME} + P_{AE}}{P_{ME} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.5068
26	$EEDI$	$\frac{[P_{ME} \times (C_{FPilotfuel} \times SFC_{ME Pilotfuel} + C_{FLNG} \times SFC_{ME LNG}) + P_{AE} \times (C_{FPilotfuel} \times SFC_{AE Pilotfuel} + C_{FLNG} \times SFC_{AE LNG})]}{(V_{ref} \times Capacity)}$	gCO ₂ /tnm	2.78

Case 3: LNG is not regarded as the “primary fuel” if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with smaller LNG tanks:



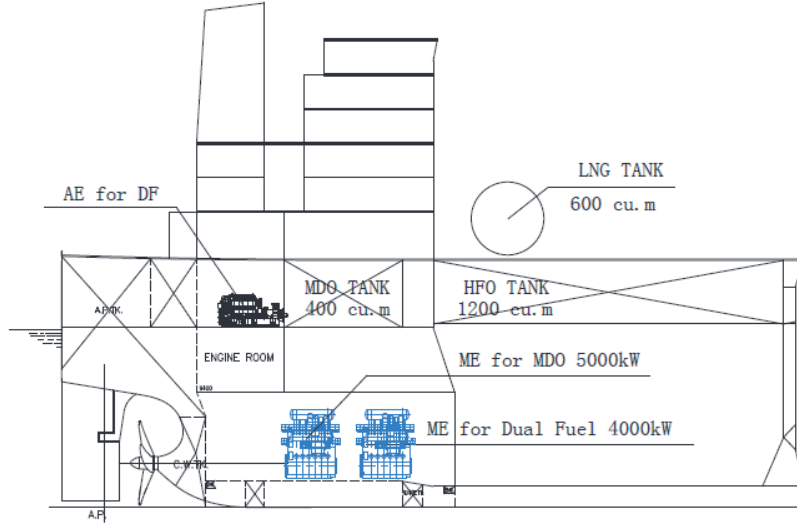
S/N	Parameter	Formula or source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	$Capacity$	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	$0.75 \times MCR_{ME}$	kW	7447.5
5	P_{AE}	$0.05 \times MCR_{ME}$	kW	496.5
6	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$C_{FAEPilotfuel}$	C_F factor of pilot fuel for auxiliary engine using MDO	-	3.206
8	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
10	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel Meat P_{ME}	g/kWh	6
11	$SFC_{AEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
12	$SFC_{ME LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
13	$SFC_{AE LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
14	$SFC_{ME MDO}$	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	165
15	SFC_{AEMDO}	Specific fuel consumption of dual fuel AE using MDO at P_{AE}	g/kWh	187
16	V_{LNG}	LNG tank capacity on board	m ³	600
17	V_{HFO}	Heavy fuel oil tank capacity on board	m ³	1800
18	V_{MDO}	Marine diesel oil tank capacity on board	m ³	400
19	ρ_{LNG}	Density of LNG	kg/m ³	450
20	ρ_{HFO}	Density of heavy fuel oil	kg/m ³	991
21	ρ_{MDO}	Density of marine diesel oil	kg/m ³	900
22	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
23	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
24	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
25	K_{LNG}	Filling rate of LNG tank	-	0.95
26	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
27	K_{MDO}	Filling rate of marine diesel tank	-	0.98
28	f_{DFgas}	$\frac{P_{ME} + P_{AE} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{P_{ME} + P_{AE} \times V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}}{P_{ME} + P_{AE} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{P_{ME} + P_{AE} \times V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}}$	-	0.1261
29	$f_{DFliquid}$	$1 - f_{DFgas}$	-	0.8739
30	$EEDI$	$\frac{[P_{ME} \times (f_{DFgas} \times (C_{FPilotfuel} \times SFC_{MEPilotfuel} + C_{FLNG} \times SFC_{ME LNG}) + f_{DFliquid} \times C_{FMDO} \times SFC_{ME MDO}) + P_{AE} \times (f_{DFgas} \times (C_{FAEPilotfuel} \times SFC_{AEPilotfuel} + C_{FLNG} \times SFC_{AE LNG}) + f_{DFliquid} \times C_{FMDO} \times SFC_{AEMDO})]}{(V_{ref} \times Capacity)}$	gCO ₂ /tnm	3.61

Case 4: One dual-fuel main engine (LNG, pilot fuel MDO) and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could be regarded as “primary fuel” only for the dual-fuel main engine:



S/N	Parameter	Formula or source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	$Capacity$	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
5	P_{MEMDO}	$0.75 \times MCR_{MEMDO}$	kW	3750
6	P_{AELNG}	$0.75 \times MCR_{MELNG}$	kW	3000
7	P_{AE}	$0.05 \times (MCR_{MEMDO} + MCR_{MELNG})$	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAEPilotfuel}$	C_F factor of pilot fuel for auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
13	$SFC_{AEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
14	$SFC_{DF LNG}$	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	$SFC_{AE LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	$SFC_{ME MDO}$	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
17	V_{LNG}	LNG tank capacity on board	m ³	1000
18	V_{HFO}	Heavy fuel oil tank capacity on board	m ³	1200
19	V_{MDO}	Marine diesel oil tank capacity on board	m ³	400
20	ρ_{LNG}	Density of LNG	kg/m ³	450
21	ρ_{HFO}	Density of heavy fuel oil	kg/m ³	991
22	ρ_{MDO}	Density of marine diesel oil	kg/m ³	900
23	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
24	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
25	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
26	K_{LNG}	Filling rate of LNG tank	-	0.95
27	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
28	K_{MDO}	Filling rate of marine diesel tank	-	0.98
29	f_{DFgas}	$\frac{P_{MEMDO} + P_{MELNG} + P_{AE}}{P_{MELNG} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.5195
30	$EEDI$	$\frac{[P_{MELNG} \times (C_{FPilotfuel} \times SFC_{ME Pilotfuel} + C_{FLNG} \times SFC_{DF LNG}) + P_{MEMDO} \times C_{FMDO} \times SFC_{ME MDO} + P_{AE} \times (C_{FAEPilotfuel} \times SFC_{AE Pilotfuel} + C_{FLNG} \times SFC_{AE LNG})]}{(V_{ref} \times Capacity)}$	gCO ₂ /tnm	3.28

Case 5: One dual-fuel main engine (LNG, pilot fuel MDO), and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could not be regarded as “primary fuel” for the dual-fuel main engine:



S/N	Parameter	Formula or source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	$Capacity$	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
5	P_{MEMDO}	$0.75 \times MCR_{MEMDO}$	kW	3750
6	P_{AELNG}	$0.75 \times MCR_{MELNG}$	kW	3000
7	P_{AE}	$0.05 \times (MCR_{MEMDO} + MCR_{MELNG})$	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAEPilotfuel}$	C_F factor of pilot fuel for auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	2.75
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
13	$SFC_{AEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
14	SFC_{DFLNG}	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	SFC_{AELNG}	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	SFC_{DFMDO}	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	185
17	SFC_{MEMDO}	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
18	SFC_{AEMDO}	Specific fuel consumption of AE using MDO at P_{AE}	g/kWh	187
19	V_{LNG}	LNG tank capacity on board	m ³	600
20	V_{HFO}	Heavy fuel oil tank capacity on board	m ³	1200
21	V_{MDO}	Marine diesel oil tank capacity on board	m ³	400
22	ρ_{LNG}	Density of LNG	kg/m ³	450
23	ρ_{HFO}	Density of heavy fuel oil	kg/m ³	991
24	ρ_{MDO}	Density of marine diesel oil	kg/m ³	900
25	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
26	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
27	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
28	K_{LNG}	Filling rate of LNG tank	-	0.95
29	K_{HFO}	Filling rate of heavy fuel oil	-	0.98
30	K_{MDO}	Filling rate of marine diesel tank	-	0.98
31	f_{DFgas}	$\frac{P_{MEMDO} + P_{AELNG} + P_{AE}}{P_{MELNG} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.3462
32	$f_{DFliquid}$	$1 - f_{DFgas}$	-	0.6538
33	$EEDI$	$\frac{[P_{MELNG} \times (f_{DFgas} \times (C_{FPilotfuel} \times SFC_{MEPilotfuel} + C_{FLNG} \times SFC_{DFLNG}) + f_{DFliquid} \times C_{FMDO} \times SFC_{DFMDO}) + P_{MEMDO} \times C_{FMDO} \times SFC_{MEMDO} + P_{AE} \times (f_{DFgas} \times (C_{FAEPilotfuel} \times SFC_{AEPilotfuel} + C_{FLNG} \times SFC_{AELNG}) + f_{DFliquid} \times C_{FMDO} \times SFC_{AEMDO})]}{(V_{ref} \times Capacity)}$	gCO ₂ /tnm	3.54

Appendix 1-2 Guidelines for Calculation of the Attained EEDI for Sea-going Ships Engaged on Domestic Voyages

1 These Guidelines apply to calculation of the Attained EEDI for sea-going ships engaged on domestic voyages applying for CDx class notation as described in 4.2.2 of the Rules.

2 Attained EEDI calculation formula

The Attained EEDI means the attained ship Energy Efficiency Design Index, which is a measure of ship energy efficiency (g/t-nmile) and calculated by the following formula:

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

* If part of the normal maximum sea load is provided by shaft generators, for that part of the power, SFC_{ME} and C_{FME} may be used instead of SFC_{AE} and C_{FAE} .

If $0.75 \cdot \sum_{i=1}^{nPTO} P_{PTO(i)} \leq P_{AE}$, $P_{AE} \cdot C_{FAE} \cdot SFC_{AE}$ may be replaced by:

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

If $0.75 \cdot \sum_{i=1}^{nPTO} P_{PTO(i)} > P_{AE}$, $P_{AE} \cdot C_{FAE} \cdot SFC_{AE}$ may be replaced by:

$$P_{AE} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$$

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

3 Definition and selection of parameters in Attained EEDI calculation formula

3.1 Carbon conversion factor (C_F)

C_F is a non-dimensional conversion factor between fuel consumption and CO₂ emission based on carbon content, measured in t-CO₂/t-Fuel. The subscripts MEi and AEi refer to the main and auxiliary engine(s) respectively. C_F is the carbon conversion factor corresponds to the fuel used when determining SFC listed in the applicable test report included in a Technical File as defined in NO_x Technical Code (hereinafter referred to as “test report included in a NO_x technical file”). The value of C_F is shown in Table 3.1.

Carbon Conversion Factor C_F

Table 3.1

Type of fuel	Reference	Lower calorific value(kJ/kg)	Carbon content	C_F (t-CO ₂ /t-Fuel)
1. Diesel/Gas Oil	ISO 8217 Grades DMX through DMC	42,700	0.8744	3.206
2. Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41,200	0.8594	3.151
3. Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40,200	0.8493	3.114
4. Liquefied Petroleum Gas (LPG)	Propane	46,300	0.8182	3.000
	Butane	45,700	0.8264	3.030
5. Liquefied Natural Gas (LNG)		48,000	0.7500	2.750
6. Methanol		19,900	0.3750	1.375
7. Ethanol		26,800	0.5217	1.913

In case of a ship equipped with a dual-fuel main or auxiliary engine, the C_F -factor for gas fuel and the C_F -factor for fuel oil are to apply and be multiplied with the specific fuel consumption of each fuel at the relevant EEDI load point. Meanwhile, gas fuel is to be identified whether it is regarded as the “primary fuel” in accordance with the formula below:

$$f_{DFgas} = \frac{\sum_{i=1}^{ntotal} P_{total(i)}}{\sum_{i=1}^{ngasfuel} P_{gasfuel(i)}} \times \frac{V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}{\left[\sum_{i=1}^{nliquid} V_{liquid(i)} \times \rho_{liquid(i)} \times LCV_{liquid(i)} \times K_{liquid(i)} \right] + V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}$$

$$f_{DFliquid} = 1 - f_{DFgas}$$

where: f_{DFgas} – the fuel availability ratio of gas fuel corrected for the power ratio of gas engines to total engines, f_{DFgas} is not to be greater than 1;

V_{gas} – the total net gas fuel capacity on board in m^3 . If other arrangements, like exchangeable (specialized) LNG tank-containers and/or arrangements allowing frequent gas refueling are used, the capacity of the whole LNG fuelling system is to be used for V_{gas} . The boil-off rate (BOR) of gas cargo tanks can be calculated and included to V_{gas} if it is connected to the fuel gas supply system (FGSS);

V_{liquid} – the total net liquid fuel capacity on board in m^3 of liquid fuel tanks permanently connected to the ship’s fuel system. If one fuel tank is disconnected by permanent sealing valves, V_{liquid} of the fuel tank can be ignored;

ρ_{gas} – the density of gas fuel in kg/m^3 ;

ρ_{liquid} – the density of each liquid fuel in kg/m^3 ;

LCV_{gas} – the low calorific value of gas fuel in kJ/kg ;

LCV_{liquid} – the low calorific value of liquid fuel in kJ/kg ;

K_{gas} – the filling rate for gas fuel tanks;

K_{liquid} – the filling rate for liquid fuel tanks;

P_{total} – the total installed engine power, P_{ME} and P_{AE} in kW;

$P_{gasfuel}$ – the dual fuel engine installed power, P_{ME} and P_{AE} in kW;

1. If the total gas capacity is at least 50% of the fuel capacity dedicated to the dual fuel engines, namely $f_{DFgas} \geq 0.5$, then gas fuel is regarded as the “primary fuel”, and $f_{DFgas} = 1$ and $f_{DFliquid} = 0$ for each dual fuel engine.
2. If $f_{DFgas} < 0.5$, gas fuel is not regarded as the “primary fuel”. The C_F and SFC in the EEDI calculation for each dual fuel engine (both main and auxiliary engines) are to be calculated as the weighted average of C_F and SFC for liquid and gas mode, according to f_{DFgas} and $f_{DFliquid}$, such as the original item of $P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$ in the EEDI calculation is to be replaced by the formula below:

$$P_{ME(i)} \cdot (f_{DFgas(i)} \cdot (C_{FME\ pilot\ fuel(i)} \cdot SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} \cdot SFC_{ME\ gas(i)}) + f_{DFliquid(i)} \cdot C_{FME\ liquid(i)} \cdot SFC_{ME\ liquid(i)})$$

Calculation examples are set out in Appendix 1-1.

3.2 Ship speed (V_{ref})

V_{ref} is the speed of steam turbines of the ship, measured in knot, on deep water in the condition corresponding to the Capacity as defined in paragraph 3.3 (in case of passenger ships and cruise passenger ships, this condition is to be summer load draught as provided in paragraph 3.4) at the shaft power of the engine(s) as defined in paragraph 3.5 and assuming the weather is calm with no wind and no waves.

3.3 Capacity

Capacity is defined differently for different ship types.

3.3.1 For bulk carriers, tankers and LNG carriers, deadweight (*DWT*) is to be used as capacity.

3.3.2 For containerships, 70% of the deadweight (*DWT*) is to be used as capacity. EEDI values for containerships are calculated as follows:

- (1) Attained EEDI value is to be calculated using 70% *DWT* in accordance with EEDI formula;
- (2) Required EEDI value is to be calculated using 100% *DWT* in accordance with reference line formula in 4.2.2 of the Rules.

3.4 Deadweight (*DWT*)

Deadweight 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 is to be taken as the maximum summer draught as certified in the stability booklet approved by the Administration or CCS.

3.5 Power (*P*)

P is the power of the main and auxiliary engines, measured in kW. The subscripts *ME* and *AE* refer to the main and auxiliary engine(s) respectively. The summation on *i* is for all engines with the number of engines (*nME*). Power related parameters involved in EEDI calculation formula are as follows:

3.5.1 $P_{ME(i)}$ is 75% of the rated installed power (MCR) for each main engine. The MCR value specified on the EIAPP certificate is to be used for calculation. If the main engines are not required to have an EIAPP certificate, the MCR value on the nameplate is to be used for calculation.

For LNG carriers having diesel electric propulsion system, $P_{ME(i)}$ is to be calculated by the following formula:

$$P_{ME(i)} = 0.83 \times \frac{MPP_{Motor(i)}}{\eta_{(i)}}$$

where: $MPP_{Motor(i)}$ is the rated output of motor specified in the certified document.

$\eta_{(i)}$ is to be taken as the product of electrical efficiency of generator, transformer, converter, and motor, taking into consideration the weighted average as necessary. The electrical efficiency, $\eta_{(i)}$, is to be taken as 91.3% for the purpose of calculating attained EEDI. Alternatively, if the value more than 91.3% is to be applied, the $\eta_{(i)}$ is to be obtained by measurement and verified by method approved by CCS.

For LNG carriers having steam turbine propulsion systems, $P_{ME(i)}$ is 83% of the rated installed power ($MCR_{Steam\ Turbine}$) for each steam turbine_(i).

3.5.2 $P_{PTO(i)}$ — In case where a shaft generator is installed, the shaft generator power ($P_{PTO(i)}$) is 75% of the rated electrical power output for each shaft generator. In case that shaft generator(s) are installed to steam turbine, $P_{PTO(i)}$ is 83% of the rated electrical output power and the factor of 0.75 is to be replaced to 0.83.

There are two options to calculate the effect of shaft generators:

- (1) Option 1: The maximum allowable deduction for the calculation of $\sum P_{ME(i)}$ is to be no more than P_{AE} as defined in paragraph 3.5.4. For this case, $\sum P_{ME(i)}$ is calculated as:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 \times (\sum MCR_{ME(i)} - \sum P_{PTO(i)}) \text{ with } 0.75 \times \sum P_{PTO(i)} \leq P_{AE}; \text{ or}$$

(2) Option 2: Where an engine is installed with a higher rated power output than that which the propulsion system is limited to as verified by technical means, the value of $\sum P_{ME(i)}$ is to be 75% of that limited power for determining the reference speed V_{ref} defined in 3.2 and for EEDI calculation.

Figure 3.5.2 gives guidance for determination of $\sum P_{ME(i)}$.

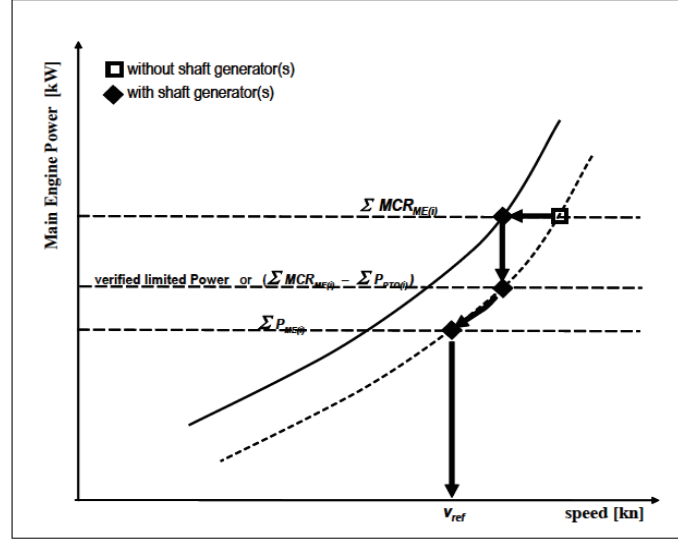


Figure 3.5.2 Determination of the Power $\sum P_{ME(i)}$ of a Main Engine

3.5.3 $P_{PTI(i)}$ —In case where shaft motor(s) are installed, $P_{PTI(i)}$ is 75% of the rated power consumption of each shaft motor divided by the weighted average efficiency of the generator(s), as follows:

$$\sum P_{PTI(i)} = \frac{\sum (0.75 \cdot P_{SM,max(i)})}{\eta_{Gen}}$$

where: $P_{SM,max(i)}$ — is the rated power consumption of each shaft motor;

η_{Gen} — is the weighted average efficiency of the generator(s).

In case that shaft motor(s) are installed to steam turbine, $P_{PTI(i)}$ is 83% of the rated power consumption and the factor of 0.75 is to be replaced to 0.83.

The propulsion power at which V_{ref} is measured, is:

$$\sum P_{ME(i)} + \sum P_{PTI(i),shaft}$$

where: $\sum P_{PTI(i),shaft} = \sum (0.75 \cdot P_{SM,max(i)} \cdot \eta_{PTI(i)})$

$\eta_{PTI(i)}$ — is the efficiency of each shaft motor installed.

Where the total propulsion power as defined above is higher than 75% of the power the propulsion system is limited to by verified technical means, then 75% of the limited power is to be used as the total propulsion power for determining the reference speed, V_{ref} as defined in 3.2 and for EEDI calculation. Then,

$(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} + \sum_{i=1}^{nPTI} P_{PTI(i)} \cdot C_{FAE} \cdot SFC_{AE})$ is to be replaced by 75% of the limited power multiplied by the weighted average value of $(SFC_{ME} \cdot C_{FME})$ and $(SFC_{AE} \cdot C_{FAE})$.

In case of combined PTI/PTO, the normal operational mode at sea will determine which of these is to be used in the EEDI calculation. For example, if this combined system is used as a shaft generator for ships in normal operation at sea, the P_{PTO} parameter is to be used in the EEDI calculation formula and P_{PTI} equals 0.

The shaft motor's chain efficiency may be taken into consideration to account for the energy losses in the equipment from the switchboard to the shaft motor, if the chain efficiency of the shaft motor is given in a verified document.

3.5.4 P_{AE} is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery/systems and accommodation, e.g. main engine pumps, navigational systems and equipment and living on board, but excluding the power not for propulsion machinery/systems, e.g. thrusters, cargo pumps, cargo gear, ballast pumps, reefers and cargo hold fans for maintaining cargo, in the condition where the ship engaged in voyage at the speed V_{ref} under the condition as mentioned in paragraph 3.2 .

P_{AE} used for the calculation of Attained EEDI of ships is to be calculated by the following experience-based formulae instead of the actual auxiliary engine power.

(1) For ships with a total propulsion power $(\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75})$ of 10,000 kW or above, P_{AE} is defined as:

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

(2) For ships with a total propulsion power $(\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75})$ below 10,000 kW, P_{AE} is defined as:

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

(3) For LNG carriers with a reliquefaction system or compressor(s), designed to be used in normal operation and essential to maintain the LNG cargo tank pressure below the maximum allowable relief valve setting of a cargo tank in normal operation, the following terms are to be added to above P_{AE} formula in accordance with 1, 2 or 3 as below:

① For LNG carriers having re-liquefaction system:

$$+ \text{CargoTankCapacity}_{LNG} \times BOR \times COP_{reliquefy} \times R_{reliquefy}$$

where: $\text{CargoTankCapacity}_{LNG}$ —the LNG Cargo Tank Capacity, in m^3 .

BOR — the design rate of boil-off gas of entire ship per day, which is specified in the specification of the building contract.

$COP_{reliquefy}$ — the coefficient of design power performance for reliquefying boil-off gas per unit volume, as follows.

$$COP_{reliquefy} = \frac{425(\text{kg/m}^3) \times 511(\text{kJ/kg})}{24(\text{h}) \times 3600(\text{sec}) \times COP_{cooling}}$$

$COP_{cooling}$ — the coefficient of design performance of reliquefaction and 0.166 is to be used. Another value calculated by the manufacturer and verified by the Administration or CCS may be used.

$R_{reliquefy}$ — the ratio of boil-off gas (BOG) to be re-liquefied to entire BOG, calculated as follows.

$$R_{reliquefy} = \frac{BOG_{reliquefy}}{BOG_{total}}$$

- ② For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying high-pressured gas derived from boil-off gas to the installed engines (typically intended for 2-stroke dual fuel engines):

$$+COP_{comp} \times \sum_{i=1}^{nME} SFC_{ME(i), gasmode} \times \frac{P_{ME(i)}}{1000}$$

where: COP_{comp} is the design power performance of compressor and 0.33 (kWh/kg) is to be used. Another value calculated by the manufacturer and verified by the Administration or an organization recognized by the Administration may be used.

- ③ For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying low-pressured gas derived from boil-off gas to the installed engines (typically intended for 4-stroke dual fuel engines):

$$+0.02 \times \sum_{i=1}^{nME} P_{ME(i)}$$

With regard to the factor of 0.02, it is assumed that the additional energy needed to compress BOG for supplying to a 4-stroke dual fuel engine is approximately equal to 2% of P_{ME} , compared to the energy needed to compress BOG for supplying to a steam turbine.

For LNG carriers having diesel electric propulsion system, $MPP_{Motor(i)}$ is to be used instead $MCR_{ME(i)}$ for P_{AE} calculation.

For LNG carriers having steam turbine propulsion system and of which electric power is primarily supplied by turbine generator closely integrated into the steam and feed water systems, P_{AE} may be treated as 0 instead of taking into account electric load in calculating $SFC_{SteamTurbine}$.

3.5.5 $P_{eff(i)}$ is the output of the innovative mechanical energy efficient technology for propulsion at 75% main engine power.

Mechanical recovered waste energy directly coupled to shafts need not be measured, since the effect of the technology is directly reflected in the V_{ref} .

In case of a ship equipped with a number of engines, the C_F and SFC are to be the power weighted average value of all the main engines.

In case of a ship equipped with a dual-fuel engine, the C_F and SFC are to be obtained according to 3.1 and 3.7.

3.5.6 $P_{AEeff(i)}$ is the auxiliary power reduction due to innovative electrical energy efficient technology measured at $P_{ME(i)}$.

3.5.7 Figure 3.5.7 below illustrates a generic marine power plant and the power used for EEDI calculation.

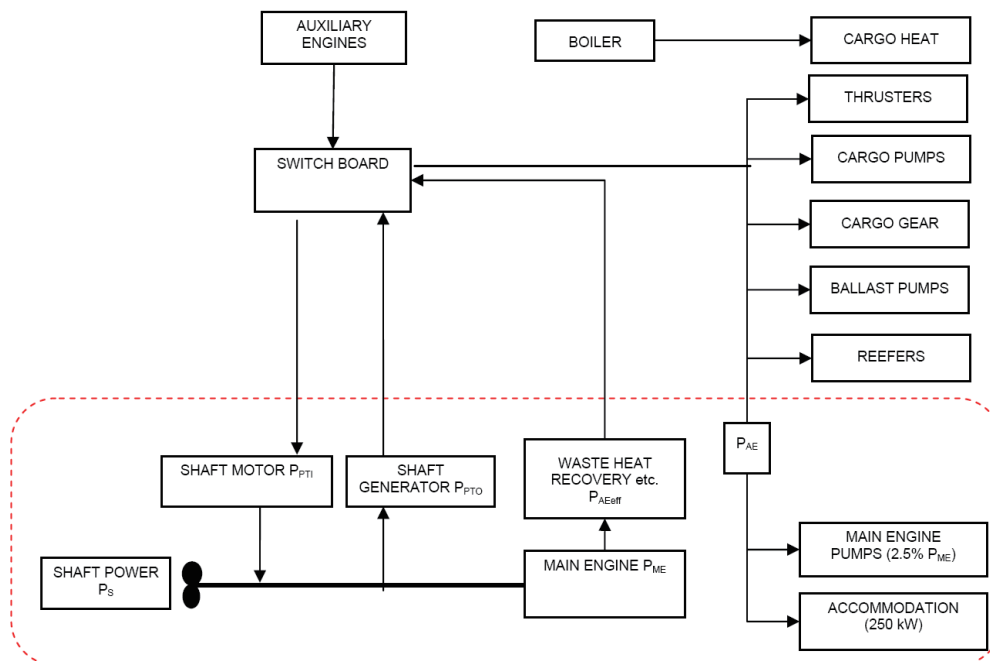


Figure 3.5.7 A Generic Marine Power Plant for Ships Having Conventional Propulsion

3.6 The essential parameters V_{ref} , Capacity and P for determining EEDI for a ship are interrelated and should be consistent with each other. As for LNG carriers having diesel electric or steam turbine propulsion systems, V_{ref} is the relevant speed at 83% of MPP_{Motor} or $MCR_{SteamTurbine}$ respectively.

3.7 Specific Fuel Consumption (SFC)

SFC is the certified specific fuel consumption, measured in g/kWh, of the engines or steam turbines. SFC_{ME} and SFC_{AE} refer to the specific fuel consumption of the main and auxiliary engine(s) respectively.

3.7.1 For engines certified to the E2 or E3 duty cycles of the NO_x Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{ME(i)}$) is that recorded in the test report included in a NO_x technical file for the engine(s) at 75% of MCR power or its torque rating.

3.7.2 For engines certified to the D2 or C1 duty cycles of the NO_x Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{AE(i)}$) is that recorded in the test report included in a NO_x technical file at the engine(s) at 50% of MCR power or its torque rating.

3.7.3 If gas fuel is used as primary fuel in accordance with paragraph 2.3.3 of CCS Guidelines for Verification of the Energy Efficiency Design Index (EEDI) of Ships, SFC in gas mode is to be used. In case that installed engine(s) have no approved NO_x Technical File tested in gas mode, the SFC of gas mode is to be submitted by the manufacturer and confirmed by CCS.

3.7.4 The SFC is to be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil (42,700kJ/kg), referring to ISO 15550:2002 and ISO 3046-1:2002.

3.7.5 For ships where the P_{AE} value calculated by 3.5.4.(1) or (2) above is significantly different from the total power used at normal seagoing, e.g., conventional passenger ships, the Specific Fuel Consumption (SFC_{AE}) of the auxiliary generators is that recorded in the test report included in a NO_x technical file for the engine(s) at 75% of MCR power or its torque rating.

3.7.6 SFC_{AE} is the power-weighted average among $SFC_{AE(i)}$ of the respective engines i .

3.7.7 For those engines which do not have EIAPP certificates because its power is below 130 kW, the SFC specified by the manufacturer and endorsed by the Administration or CCS is to be used.

3.7.8 At the design stage, in case of unavailability of a test report in the NO_x file, the SFC specified by the manufacturer and endorsed by the Administration or CCS is to be used.

3.7.9 For LNG-driven engines, *SFC* measured in kJ/kWh is to be amended to *SFC* value measured in g/kWh by using the standard lower heat value of the LNG (48,000 kJ/kg) (Refer to 2006 IPCC Guidelines).

3.7.10 The $SFC_{SteamTurbine}$ is to be calculated by manufacturer and verified by the Administration or CCS as follows:

$$SFC_{SteamTurbine} = \frac{FuelConsumption}{\sum_{i=1}^{nME} P_{ME(i)}}$$

where:

(1) Fuel consumption is fuel consumption of boiler per hour (g/h). For ships of which electric power is primarily supplied by Turbine Generator closely integrated into the steam and feed water systems, not only P_{ME} but also electric loads corresponding to paragraph 3.5.4 are to be taken into account.

(2) The *SFC* is to be corrected to the value of LNG using the standard lower calorific value of the LNG (48,000 kJ/kg) at SNAME Condition (condition standard; air temperature 24°C, inlet temperature of fan 38°C, sea water temperature 24°C).

(3) In this correction, the difference of the boiler efficiency based on lower calorific value between test fuel and LNG is to be taken into account.

3.7.11 Reference lower calorific values of additional fuels are given in the Table 3.1 of these Guidelines. The reference lower calorific value corresponding to the conversion factor of the respective fuel is to be used for calculation.

3.8 Correction factor f_j

f_j is a correction factor to account for ship specific design elements.

3.8.1 For ice-classed ships, the power of the main engine is to be increased due to navigation in ice. Therefore an additional correction factor is applied to compensate for negative effects caused by the increased power on EEDI of such ships. This factor is to be taken as the greater value of f_{j0} and $f_{j,min}$ as tabulated in Table 3.8.1, but not to be greater than 1.0.

Correction factor for power f_j for ice-classed ships

Table 3.8.1

Ship type	f_{j0}	$f_{j,min}$ depending on the ice class			
		IA Super	IA	IB	IC
Tanker	$\frac{17.444 \cdot DWT^{0.5766}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.2488 \cdot DWT^{0.0903}$	$0.4541 \cdot DWT^{0.0524}$	$0.7783 \cdot DWT^{0.0145}$	$0.8741 \cdot DWT^{0.0079}$
Bulk carrier	$\frac{17.207 \cdot DWT^{0.5705}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.2515 \cdot DWT^{0.0851}$	$0.3918 \cdot DWT^{0.0556}$	$0.8075 \cdot DWT^{0.0071}$	$0.8573 \cdot DWT^{0.0087}$

Note: B1*, B1, B2 and B3 are ice class notations in CCS Rules for Classification of Sea-going Steel Ships, corresponding to IA Super, IA, IB and IC ice class in the Finnish-Swedish Ice Class Rules (FSICR) respectively.

Alternatively, if an ice-class ship is designed and constructed based on an open water ship with same shape and size of hull with EEDI certification, the power correction factor, f_j , for ice-classed ships can be calculated by using propulsion power of the new ice-class ship required by ice-class regulations, $P_{ice\ class}$, and the existing open water ship, P_{ow} , as follows:

$$f_j = \frac{P_{ow}}{P_{ice\ class}}$$

In this case, V_{ref} should be measured at the shaft power of the engine(s) installed on the existing open water ship as defined in paragraph 3.5.

3.8.2 The power correction factor f_j , for shuttle tankers with propulsion redundancy is to be $f_j = 0.77$. This correction factor applies to the above-mentioned shuttle tankers with propulsion redundancy and having a deadweight of 80,000 ~ 160,000 tonnes. The shuttle tankers with propulsion redundancy are tankers used for loading of crude oil from offshore installations and equipped with dual-engine and twin-propellers, need to meet the requirements for dynamic positioning and redundancy propulsion class notation.

3.8.3 For other ship types not included in the above table, f_j is to be taken as 1.0.

3.9 Correction factor f_i

f_i is the capacity correction factor for any technical/regulatory limitation on capacity, which is used to compensate for negative effects on EEDI due to the loss of capacity, and can be assumed 1.0 if no necessity of the factor is granted.

3.9.1 For ice-classed ships, the capacity is decreased due to the increased ship weight resulting from the increased steel plate thickness for guaranteeing their ice breaking capability. Therefore this capacity correction factor is applied to compensate for the loss of capacity. The capacity correction factor, f_i , for ice-classed ships having DWT as the measure of capacity should be calculated as follows:

$$f_i = f_{i(iceclass)} \cdot f_{iC_b},$$

where $f_{i(iceclass)}$ is the capacity correction factor for ice-strengthening of the ship, which can be obtained from Table 3.9.1(1) and f_{iC_b} is the capacity correction factor for improved ice-going capability, which should not be less than 1.0 and which should be calculated as follows:

$$f_{iC_b} = \frac{C_{reference\ design}}{C_b},$$

where $C_{reference\ design}$ is the average block coefficient for the ship type, which can be obtained from Table 3.9.1(2) for bulk carriers and oil tankers, and C_b is the block coefficient of the ship. For ship types other than bulk carriers and oil tankers, $f_{iC_b} = 1.0$.

Capacity correction factor for ice-strengthening of the hull **Table 3.9.1(1)**

Ice class ⁷	$f_{i(ice\ class)}$
IC	$f_{i(IC)} = 1.0041 + 58.5/DWT$
IB	$f_{i(IB)} = 1.0067 + 62.7/DWT$
IA	$f_{i(IA)} = 1.0099 + 95.1/DWT$
IA Super	$f_{i(IAS)} = 1.0151 + 228.7/DWT$

Average block coefficients $C_{reference\ design}$ for bulk carriers and oil tankers Table 3.9. 1(2)

	Size categories				
Ship type	below 10,000 DWT	10,000 ~25,000 DWT	25,000~55,000 DWT	55,000~75,000 DWT	above 75,000 DWT
Bulk carrier	0.78	0.80	0.82	0.86	0.86
Tanker	0.78	0.78	0.80	0.83	0.83

Alternatively, the capacity correction factor for ice-strengthening of the ship ($f_{i(iceclass)}$) can be calculated by using the formula given for the ship specific voluntary enhancement correction coefficient ($f_{i\ VSE}$) in paragraph 3.9.2. This formula can also be used for other ice classes than those given in Table 3.9.1(1).

3.9.2 For ships with voluntary structural enhancements, $f_{i\ VSE}$ is to be expressed as follows:

$$f_{i\ VSE} = \frac{DWT_{reference\ design}}{DWT_{enhanced\ design}}$$

where: $DWT_{reference\ design} = \Delta_{ship} - lightweight_{reference\ design}$;

$$DWT_{enhanced\ design} = \Delta_{ship} - lightweight_{enhanced\ design} .$$

For this calculation, the same displacement (Δ) is to be taken for reference and enhanced designs.

Note: Structural and/or additional class notations such as, but not limited to, “strengthened for discharge with grabs” and “strengthened bottom for loading/unloading aground”, which result in a loss of deadweight of the ship, are also seen as examples of “voluntary structural enhancements”.

(1) DWT before enhancements ($DWT_{reference\ design}$) is the deadweight prior to application of the structural enhancements. DWT after enhancements ($DWT_{enhanced\ design}$) is the deadweight following the application of voluntary structural enhancements.

(2) Where any change is made to the material (e.g. from aluminum alloy to steel) or in steel grades of the same material (e.g. in steel types, grades, properties and conditions) between reference design and voluntarily enhanced design, $f_{i\ VSE}$ is not to be used to correct the deadweight.

(3) Two sets of structural plans of the ship (one set for the reference design and the other set for the enhanced design) are to be submitted to CCS for assessment. As an alternative, only one set of structural plans of the reference design with annotations of voluntary structural enhancements may be submitted. Both sets of structural plans are to comply with the applicable regulations for the ship type and intended trade.

3.9.3 For other ship types not included in the table above, f_i is to be taken as 1.0.

3.9.4 The above factor f_i may be accumulated (multiplied).

3.10 Cubic capacity correction factor f_c

f_c is the cubic capacity correction factor and is to be taken as 1.0 if no necessity of the factor is granted. It is calculated as follows:

3.10.1 For chemical tankers, the cubic capacity correction factor f_c is to be:

$$f_c = R^{(-0.7)} - 0.014 \quad \text{for } R < 0.98; \text{ or}$$

$$f_c = 1.00 \quad \text{for } R \geq 0.98$$

where: R is the ratio of the ship's DWT (in tonnes) to the total cubic capacity (in m^3) of its cargo tanks (m^3).

3.10.2 For bulk carriers having R of less than 0.55 (e.g. wood chip carriers), the following cubic capacity correction factor, $f_{c \text{ bulk carriers designed to carry light cargoes}}$, is to apply:

$$f_{c \text{ bulk carriers designed to carry light cargoes}} = R^{-0.15}$$

where: R — the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 3.4 divided by the total cubic capacity of the cargo holds of the ship (m^3).

3.11 Energy efficiency factor f_{eff}

f_{eff} is the availability factor of each innovative energy efficiency technology. f_{eff} for waste energy recovery system is to be taken as 1.0.

3.12 Length between perpendiculars (L_{pp})

L_{pp} means 96% of the total length on a waterline at 85% of the least moulded depth measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, if that were greater. For ships designed with a rake of keel, the waterline on which this length is measured is to be parallel to the designed waterline. L_{pp} is to be measured in m.

3.13 Volumetric displacement ∇

Volumetric displacement, ∇ , in cubic metres (m^3), is the volume of the moulded displacement of the ship, excluding appendages, in a ship with a metal shell, and is the volume of displacement to the outer surface of the hull in a ship with a shell of any other material, both taken at the summer load line draught, d_s , as stated in the approved stability booklet/loading manual.

3.14 Summer load line draught, d_s

d_s is the vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to the summer freeboard draught to be assigned to the ship.

3.15 Breadth, B_s

B_s is the greatest moulded breadth of the ship, in metres, at or below the load line draught, d_s .

3.16 Gravitational acceleration g

g is the gravitational acceleration, $9.81 m/s^2$.

3.17 Factor for ice-classed ships having IA Super and IA, f_m

For ice-classed ships having IA Super or IA, the following factor, f_m , should apply:

$$f_m = 1.05$$

Appendix 2 Guidelines for the Development of Electric Power Tables for EEDI (EPT-EEDI)

1 Introduction to the document “Electric Power Table for EEDI”

1 This Appendix contains a guideline for the document “Electric Power Table for EEDI” which is similar to the actual shipyards’ load balance document, utilizing well defined criteria, providing standard format, clear loads definition and grouping, standard load factors, etc. A number of new definitions (in particular the “groups”) are introduced, giving an apparent greater complexity to the calculation process. However, this intermediate step to the final calculation of P_{AE} stimulates all the parties to a deep investigation through the global figure of the auxiliary load, allowing comparisons between different ships and technologies and eventually identifying potential efficiencies improvements.

2 Auxiliary load power definition

2.1 P_{AE} is to be calculated as indicated in 3.5.4 of Appendix 1, together with the following additional three conditions:

- (1) no emergency situations (e.g., “no fire”, “no flood”, “no blackout”, “no partial blackout”);
- (2) evaluation time frame of 24 hours (to account loads with intermittent use); and
- (3) ship fully loaded of passengers and crew.

3 Definition of the data to be included in the Electric Power Table for EEDI

3.1 The Electric Power Table for EEDI calculation is to contain the following data elements, as appropriate:

- (1) Load’s group;
- (2) Load’s description;
- (3) Load’s identification tag;
- (4) Load’s electric circuit Identification;
- (5) Load’s mechanical rated power “ P_m ” [kW];
- (6) Load’s electric motor rated output power [kW];
- (7) Load’s electric motor efficiency “ e ” [/];
- (8) Load’s Rated electric power “ P_r ” [kW];
- (9) Service factor of load “ k_l ” [/];
- (10) Service factor of duty “ k_d ” [/];
- (11) Service factor of time “ k_t ” [/];
- (12) Service total factor of use “ k_u ” [/], where $k_u = k_l \cdot k_d \cdot k_t$;

- (13) Load's necessary power " P_{load} " [kW], where $P_{load} = P_r \cdot k_u$;
- (14) Notes;
- (15) Group's necessary power [kW]; and
- (16) Auxiliaries load's power P_{AE} [kW].

4 Data to be included in the Electric Power Table for EEDI

4.1 Load groups

The Loads are put into defined groups, allowing a proper breakdown of the auxiliaries. This eases the verification process and makes it possible to identify those areas where load reductions might be possible. The groups are listed below:

- (1) A – Hull, deck, navigation and safety services;
- (2) B – Propulsion service auxiliaries;
- (3) C – Auxiliary engine and main engine services;
- (4) D – Ship's general services;
- (5) E – Ventilation for engine rooms and auxiliaries room;
- (6) F – Air conditioning services;
- (7) G – Galleys, refrigeration and laundry services;
- (8) H – Accommodation services;
- (9) I – Lighting and socket services;
- (10) L – Entertainment services;
- (11) N – Cargo loads; and
- (12) M – Miscellaneous.

All the ship's loads have to be delineated in the document, excluding only P_{Aeff} , the shaft motors and shaft motors chain (while the propulsion services auxiliaries are partially included below in paragraph 4.1.2 B). Some loads (i.e. thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, reefers and cargo hold fans) still are included in the group for sake of transparency, however their service factor is zero in order to comply with the requirements for calculation of P_{AE} in 3.5.4 of Appendix 1, therefore making it easier to verify that all the loads have been considered in the document and there are no loads left out of the measurement.

4.1.1 A – Hull, deck, navigation and safety services

- (1) Loads included in the hull services typically are: ICCP systems, mooring equipment, various doors, ballasting systems, bilge systems, stabilizing equipment, etc. Ballasting systems are indicated with service factor equal to zero to comply with the requirements for calculation of P_{AE} in 3.5.4 of Appendix 1;

(2) Loads included in the deck services typically are: deck and balcony washing systems, rescue systems, cranes, etc.;

(3) Loads included in the navigation services typically are: navigation systems, navigation's external and internal communication systems, steering systems, etc.; and

(4) Loads included in the safety services typically are: active and passive fire systems, emergency shutdown systems, public address systems, etc.

4.1.2 B – Propulsion service auxiliaries

This group typically includes: propulsion secondary cooling systems such as LT cooling pumps dedicated to shaft motors, LT cooling pumps dedicated to propulsion converters, propulsion UPSs, etc. Propulsion service loads do not include shaft motors ($PTI(i)$) and the auxiliaries which are part of them (shaft motor own cooling fans and pumps, etc.) and the shaft motor chain losses and auxiliaries which are part of them (i.e. shaft motor converters including relevant auxiliaries such as converter own cooling fans and pumps, shaft motor transformers including relevant auxiliaries losses such as propulsion transformer own cooling fans and pumps, shaft motor harmonic filter including relevant auxiliaries losses, shaft motor excitation system including the relevant auxiliaries consumed power etc.). Propulsion service auxiliaries include manoeuvring propulsion equipment such as manoeuvring thrusters and their auxiliaries whose service factor is to be set to zero.

4.1.3 C – Auxiliary engine and main engine services

This group includes: cooling systems, i.e. pumps and fans for cooling circuits dedicated to alternators or propulsion shaft engines (sea water, technical water dedicated pumps, etc.), lubricating and fuel systems feeding, transfer, treatment and storage, ventilation system for combustion air supply, etc.

4.1.4 D – Ship's general services

This group includes loads which provide general services which can be shared between shaft motor, auxiliary engines and main engine and accommodation support systems. Loads typically included in this group are: cooling systems, i.e. pumping sea water, technical water main circuits, compressed air systems, fresh water generators, automation systems, etc.

4.1.5 E – Ventilation for engine rooms and auxiliaries room

This group includes all fans providing ventilation for engine rooms and auxiliary rooms that typically are: engine rooms cooling supply-exhaust fans, auxiliary rooms supply and exhaust fans. All the fans serving accommodation areas or supplying combustion air are not included in this group. This group does not include cargo hold fans, and garage supply and exhaust fans.

4.1.6 F – Air Conditioning services

All Loads that make up the air conditioning service that typically are: air conditioning chillers, air conditioning cooling and heating fluids transfer and treatment, air conditioning's air handling units ventilation, air conditioning re-heating systems with associated pumping, etc. The air conditioning chillers service factor of load, service factor of time and service factor of duty are to be set as 1 ($k_l = 1$, $k_t = 1$ and $k_d = 1$) in order to avoid the detailed validation of the heat load dissipation document (i.e. the chiller's electric motor rated power is to be used). However, k_d is to represent the use of spare chillers (e.g., four chillers are installed and one out four is spare then $k_d = 0$ for the spare chiller and $k_d = 1$ for the remaining three chillers), but only when the number of spare chillers is clearly demonstrated via the heat load dissipation document.

4.1.7 G – Galleys, refrigeration and laundry services

All Loads related to the galleys, pantries refrigeration and laundry services that typically are: galleys various machines, cooking appliances, galleys' cleaning machines, galleys auxiliaries, refrigerated room systems including refrigeration compressors with auxiliaries, air coolers, etc.

4.1.8 H – Accommodation services

All Loads related to the accommodation services of passengers and crew that typically are: crew and passengers' transportation systems, i.e. lifts, escalators, etc., environmental services, i.e. black and grey water collecting, transfer, treatment, storage, discharge, waste systems including collecting, transfer, treatment, storage, etc., accommodation fluids transfers, i.e. sanitary hot and cold water pumping, etc., treatment units, pools systems, saunas, gym equipment, etc.

4.1.9 I – Lighting and socket services

All Loads related to the lighting, entertainment and socket services. As the quantity of lighting circuits and sockets within the ship may be significantly high, it is not practically feasible to list all the lighting circuits and points in the EPT for EEDI. Therefore circuits are to be grouped into subgroups aimed to identify possible improvements of efficient use of power. The subgroups are:

(1) lighting for 1) cabins, 2) corridors, 3) technical rooms/stairs, 4) public spaces/stairs, 5) engine rooms and auxiliaries' room, 6) external areas, 7) garages and 8) cargo spaces. All have to be divided by main vertical zone; and

(2) power sockets for 1) cabins, 2) corridors, 3) technical rooms/stairs, 4) public spaces/stairs, 5) engine rooms and auxiliaries' room, 6) garages and 7) cargo spaces. All have to be divided by main vertical zone.

The calculation criteria for complex groups (e.g., cabin lighting and power sockets) subgroups are to be included via an explanatory note, indicating the load composition (e.g., lights of typical cabins, TV, hair dryer, fridge, etc.).

4.1.10 L – Entertainment services

This group includes all loads related to the entertainment services that typically are: public spaces audio and video equipment, theatre stage equipment, IT systems for offices, video games, etc.

4.1.11 N – Cargo loads

This group will contain all cargo loads such as cargo pumps, cargo gear, maintaining cargo, cargo reefers loads, cargo hold fans and garage fans for sake of transparency. However, the service factor of this group is to be set to zero.

4.1.12 M – Miscellaneous

This group will contain all loads which have not been associated to the above-mentioned groups but still are contributing to the overall load calculation of the normal maximum sea load.

4.2 Loads description

This identifies the loads (for example “sea water pump”).

4.3 Loads identification tag

This tag identifies the loads according to the shipyard's standards tagging system. For example, the “PTI1 fresh water pump” identification tag is “SYIYA/C” for an example ship and shipyard. This data provides a unique identifier for each load.

4.4 Loads electric circuit identification

This is the tag of the electric circuit supplying the load. Such information allows the data validation process.

4.5 Loads mechanical rated power “ P_m ” [kW]

This data is to be indicated in the document only when the electric load is made by an electric motor driving a mechanical load (for example a fan, a pump, etc.). This is the rated power of the mechanical device driven by an electric motor.

4.6 Loads electric motor rated output power [kW]

The output power of the electric motor as per maker’s nameplate or technical specification. This data does not take part in the calculation but is useful to highlight potential over rating of the combination motor-mechanical load.

4.7 Loads electric motor efficiency “ e ” [/]

This data is to be entered in the document only when the electric load is made by an electric motor driving a mechanical load.

4.8 Loads rated electric power “ P_r ” [kW]

Typically the maximum electric power absorbed at the load electric terminals at which the load has been designed for its service, as indicated on the maker’s nameplate and/or in the maker’s technical specification. When the electric load is made by an electric motor driving a mechanical load, the load’s rated electric power is: $P_r = P_m/e$ [kW].

4.9 Service factor of load “ k_l ” [/]

It provides the reduction from the loads rated electric power to loads necessary electric power that is to be made when the load absorbs less power than its rated power. For example, in case of electric motor driving a mechanical load, a fan could be designed with some power margin, leading to the fact that the fan rated mechanical power exceeds the power requested by the duct system it serves. Another example is when a pump rated power exceed the power needed for pumping in its delivery fluid circuit. Another example in case of electric self-regulating semi-conductors: electric heating system is oversized and the rated power exceeds the power absorbed, according a factor k_l .

4.10 Service factor of duty “ k_d ” [/]

Factor of duty is to be used when a function is provided by more than one load. As all loads have to be included in the EPT for EEDI, this factor provides a correct summation of the loads. For example when two pumps serve the same circuit and they run in duty/standby, their k_d factor will be $\frac{1}{2}$ and $\frac{1}{2}$. When three compressors serve the same circuit and one runs in duty and two in standby, then k_d is $\frac{1}{3}$, $\frac{1}{3}$ and $\frac{1}{3}$.

4.11 Service factor of time “ k_t ” [/]

A factor of time based on the shipyard’s evaluation about the load duty along 24 hours of ship’s navigation as defined at paragraph 3. For example the entertainment loads operate at their power for a limited period of time, 4 hours out 24 hours; as a consequence $k_t = 4/24$. For example, the sea water cooling pumps operate at their power all the time during the navigation at V_{ref} . As a consequence $k_t = 1$.

4.12 Service total factor of use “ k_u ” [/]

The total factor of use that takes into consideration all the service factors: $k_u = k_l \cdot k_d \cdot k_t$.

4.13 Loads necessary power “ P_{load} ” [kW]

The individual user contribution to the auxiliary load power is $P_{load} = P_r \cdot k_u$.

4.14 Notes

A note, as free text, could be included in the document to provide explanations to CCS.

4.15 Groups necessary power [kW]

The summation of the “loads necessary power” from group A to N. This is an intermediate step which is not strictly necessary for the calculation of P_{AE} . However, it is useful to allow a quantitative analysis of the P_{AE} , providing a standard breakdown for analysis and potential improvements of energy saving.

4.16 Auxiliaries load’s power P_{AE} [kW]

Auxiliaries load’s power P_{AE} is the summation of the “load’s necessary power” of all the loads divided by the average efficiency of the generator(s) weighted by power.

$$P_{AE} = \Sigma P_{load}(i) / (\text{average efficiency of the generator(s) weighted by power})$$

5 Layout and organization of the data indicated in the “Electric Power Table for EEDI”

5.1 The document “Electric Power Table for EEDI” is to include general information (i.e. ship’s name, project name, document references, etc.) and a table with:

- (1) one row containing column titles;
- (2) one column for table row ID;
- (3) one column for the groups identification (“A”, “B”, etc.) as indicated in paragraphs 4.1.1 to 4.1.12 of these Guidelines;
- (4) one column for the group descriptions as indicated in paragraphs 4.1.1 to 4.1.12 of these Guidelines;
- (5) one column each for items in paragraphs 4.2 to 4.14 of these Guidelines (e.g., “load tag”, etc.);
- (6) one row dedicated to each individual load;
- (7) the summation results (i.e. summation of powers) including data from paragraphs 4.15 to 4.16 of these Guidelines; and
- (8) explanatory notes.

An example of an Electric Power Table for EEDI for a cruise postal vessel which transports passengers and have a car garage and reefer holds for fish trade transportation is indicated below. The data indicated and the type of ship is for reference only.

ELECTRIC POWER TABLE FOR EEDI			HULL "EXAMPLE"		PROJECT "EXAMPLE"									(NMSL=Normal Maximun Sea Load)	
id	Load group	Load description	Load identification tag	Load electric circuit Identification	Load mechanical rated power "Pm" [kW]	Load electric motor rated output power [kW]	Load electric motor efficiency "e" [%]	Load Rated electric power "Pr" [kW]	service factor of load "Kd" [%]	service factor of duty "Kt" [%]	service factor of time "Kt" [%]	service total factor of use "Ku" [%]	Load necessary power "Pload" [kW]	Note	
1	A	Hull cathodic protection Fwd	xxxx	yyy	n.a.	n.a.	n.a.	5.2	1	1	1*	1	5.2	*in use 24hours/day	
2	A	Hull cathodic protection mid	xxxx	yyy	n.a.	n.a.	n.a.	7.0	1	1	1*	1	7	*in use 24hours/day	
3	A	Hull cathodic protection aft	xxxx	yyy	n.a.	n.a.	n.a.	4.8	1	1	1*	1	4.8	*in use 24hours/day	
4	A	Ballast pump 3	xxxx	yyy	30	36	0.92	32.6	0.9	0.5	1	0*	0	*not in use at NMSL see para 2.5.6 of Circ.681	
5	A	Fwd Stb mooring winch motor n.1	xxxx	yyy	90	150	0.92	97.8	0.8	1	0*	0*	0	*not in use at NMSL see para 2.5.6 of Circ.681	
6	A	WTDs system main control panel	xxxx	yyy	n.a.	n.a.	n.a.	0.5	1	1	1*	1	0.5	*in use 24hours/day	
7	A	WTD 1, deck D frame 150	xxxx	yyy	1.2	3	0.91	1.3	0.7	1	0.104*	0.0728	0.096	*180 secs to open/close x 100 opening a day	
8	A	WTD 5, deck D frame 210	xxxx	yyy	1.2	3	0.91	1.3	0.7	1	0.156*	0.1092	0.14	*180 secs to open/close x 150 opening a day	
9	A	Stabilisers control unit	xxxx	yyy	n.a.	n.a.	n.a.	0.7	1	1	1*	1	0.7	*in use 24hours/day	
10	A	Stabilisers Hydraulic pack power pump 1	xxxx	yyy	80	90	0.9	88.9	0.9	1	0*	0	0	*NMSL=> calm sea=> stabiliser not in use	
11	A	S-band Radar 1 controller	xxxx	yyy	n.a.	n.a.	n.a.	0.4	1	1	1*	1	0.4	*in use 24hours/day	
12	A	S-band Radar 1 motor	xxxx	yyy	0.8	1	0.92	0.9	1	1	1*	1	0.9	*in use 24hours/day	
13	A	Fire detection system bridge main unit	xxxx	yyy	n.a.	n.a.	n.a.	1.5	1	1	1*	1	1.5	*in use 24hours/day	
14	A	Fire detection system ECR unit	xxxx	yyy	n.a.	n.a.	n.a.	0.9	1	1	1*	1	0.9	*in use 24hours/day	
15	A	High pressure water fog contol unit	xxxx	yyy	n.a.	n.a.	n.a.	1.2	1	1	1*	1	1.2	*in use 24hours/day	
16	A	High pressure water fog engines rooms pump 1a	xxxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0	0	*NMSL=> not emergency =>Load not in use	
17	A	High pressure water fog engines rooms pump 1b	xxxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0	0	* not emergency situations	
18	B	PTI port fresh water pump 1	xxxx	yyy	30	36	0.92	32.6	0.9	0.5*	1	0.45	14.7	* pump1,2 one is duty and one is stand-by	
19	B	PTI port fresh water pump 2	xxxx	yyy	30	36	0.92	32.6	0.9	0.5*	1	0.45	14.7	* pump1,2 one is duty and one is stand-by	
20	B	Thrusters control system	xxxx	yyy	n.a.	n.a.	n.a.	0.5	1	1	1*	1	0.5	in use 24hours/day (even if thruster motor isn't)	
21	B	Bow thruster 1	xxxx	yyy	3000	3000	0.96	3125.0	1	1	0*	0	0	*NMSL=>thrusters motor are not in use	
22	B	PEM port cooling fan 1	xxxx	yyy	20	25	0.93	21.5	0.9	1	n.a.	n.a	n.a.*	*this load is included in the propulsion chain data	
23	C	HT circulation pump 1 DG 3	xxxx	yyy	8	10	0.92	8.7	0.9	0.5*	1	0.45	3.9	* pump1,2 one is duty and one is stand-by	
24	C	HT circulation pump 2 DG 3	xxxx	yyy	8	10	0.92	8.7	0.9	0.5*	1	0.45	3.9	* pump1,2 one is duty and one is stand-by	
25	C	DG3 combustion air fan	xxxx	yyy	28	35	0.92	30.4	0.9	1	1*	0.9	27.4	*in use 24hours/day	
26	C	DG3 exhaust gas boiler circulationg pump	xxxx	yyy	6	8	0.93	6.5	0.8	1	1*	0.8	5.2	*in use 24hours/day	
27	C	Alternator 3 external cooling fan	xxxx	yyy	3	5	0.93	3.2	0.8	1	1*	0.8	2.75	*in use 24hours/day	
28	C	fuel feed fwd booster pump a	xxxx	yyy	7	9	0.92	7.6	0.9	0.5*	1	0.45	3.4	* pump1,2 one is duty and one is stand-by	
29	C	fuel feed fwd booster pump b	xxxx	yyy	7	9	0.92	7.6	0.9	0.5*	1	0.45	3.4	* pump1,2 one is duty and one is stand-by	
30	D	Fwd main LT cooling pump 1	xxxx	yyy	120	150	0.95	126.3	0.9	0.5*	1	0.45	56.8	* pump1,2 one is duty and one is stand-by	
31	D	Fwd main LT cooling pump 2	xxxx	yyy	120	150	0.95	126.3	0.9	0.5*	1	0.45	56.8	* pump1,2 one is duty and one is stand-by	
32	E	FWD engine room supply fan 1	xxxx	yyy	87.8	110	0.93	94.4	0.95	1	1*	0.95	89.7	*in use 24hours/day	
33	E	FWD engine room exhaust fan 1	xxxx	yyy	75	86	0.93	80.6	0.96	1	1*	0.96	77.4	*in use 24hours/day	
34	E	purifier room supply fan 1	xxxx	yyy	60	70	0.93	64.5	0.96	0.5	1*	0.48	31.0	*in use 24hours/day	
35	E	purifier room supply fan 2	xxxx	yyy	60	70	0.93	64.5	0.96	0.5	1*	0.48	31.0	*in use 24hours/day	
36	F	HVAC chiller a	xxxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.	
37	F	HVAC chiller b	xxxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.	
38	F	HVAC chiller C	xxxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.	
39	F	A.H.U. Ac station 5.4 supply fan	xxxx	yyy	50	60	0.93	53.8	0.9	1	1*	0.9	48.4	*in use 24hours/day	
40	F	A.H.U. Ac station 5.4 exhaust fan	xxxx	yyy	45	55	0.93	48.4	0.9	1	1*	0.9	43.5	*in use 24hours/day	
41	F	Chilled water pump a	xxxx	yyy	80	90	0.93	86.0	0.88	0.5*	1	0.44	37.8	* pump1,2 one is duty and one is stand-by	
42	F	Chilled water pump b	xxxx	yyy	80	90	0.93	86.0	0.88	0.5*	1	0.44	37.8	* pump1,2 one is duty and one is stand-by	
43	G	Italian's espresso coffee machine	xxxx	yyy	n.a.	n.a.	n.a.	7.0	0.9	1	0.2*	0.18	1.3	*in use 4.8hours/day	
44	G	deep freezer machine	xxxx	yyy	n.a.	n.a.	n.a.	20.0	0.8	1	0.16*	0.128	3.2	*in use 4hours/day	
45	G	washing machine 1	xxxx	yyy	n.a.	n.a.	n.a.	8.0	0.8	1	0.33*	0.264	3.2	*in use 8hours/day	
46	H	lift pax mid 4	xxxx	yyy	30	40	0.93	32.3	0.5	1	0.175*	0.0875	0.9	*in use 4hours/day	
47	H	vacuum collecting system 4 pump a	xxxx	yyy	10	13	0.92	10.9	0.9	1	1*	0.9	8.7	*in use 24hours/day	
48	H	sewage treatmet system 1 pump 1	xxxx	yyy	15	17	0.93	16.1	0.9	1	1*	0.9	8.7	*in use 24hours/day	
49	H	Gym running machine	xxxx	yyy	n.a.	n.a.	n.a.	2.5	1	1	0.3*	0.3	0.8	*in use 7.2hours/day	
50	I	Cabin's lighting MV23	n.a.	n.a.	n.a.	n.a.	n.a.	80*	1	1	1	1	80.0	* see explanatory note	
51	I	corridors lighing MV23	n.a.	n.a.	n.a.	n.a.	n.a.	10*	1	1	1	1	10.0	* see explanatory note	
52	I	Cabin's sockets MV23	n.a.	n.a.	n.a.	n.a.	n.a.	5*	1	1	1	1	5.0	* see explanatory note	
53	L	Main Theatre audio booster amplifier	xxxx	yyy	n.a.	n.a.	n.a.	15.0	1	1	0.3*	0.3	4.5	*in use 7.2hours/day	
54	L	Video wall atrium	xxxx	yyy	n.a.	n.a.	n.a.	2.0	1	1	0.3*	0.3	0.6	*in use 7.2hours/day	
55	M	Car Garage supply fan1	xxxx	yyy	28	35	0.92	30.4	0.9	1	1*	0*	0	*not in use at NMSL see para 2.5.6 of Circ.681	
56	M	Fish transportation refeer hold n.2	xxxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0*	0	*not in use at NMSL see para 2.5.6 of Circ.681	
57	N	Sliding glass roof	xxxx	yyy	30	40	0.93	32.3	0.9	1	0.3*	0.27	0.2	*in use 7.2hours/day	
													ΣPload(i)=	3764	
PAE=3764/(weighted average efficiency of generator(s)) [kW] Group's necessary power (group A=22.9kW, B=29.8kW,C=49.9kW, D=113.7kW, E=229kW , F=3189kW, G=7.6kW, H=19kW, I=95kW, L=5.1kW, M=0kW, N=0.22kW)															

Appendix 3 Interim Guidelines for Determining Minimum Propulsion Power to Maintain the Manoeuvrability of Ships in Adverse Conditions

0 Purpose

The purpose of the interim guidelines is to provide guidance in verifying that ships, complying with CO₂ emission requirements set out in 2.3.2 of the Rules, have sufficient installed propulsion power to maintain the manoeuvrability in adverse conditions.

1 Definition

1.1 “Adverse conditions” mean sea conditions with the following parameters:

Significant wave height h_s , m	Peak wave period T_p , s	Mean wind speed V_w , m/s
5.5	7.0 to 15.0	19.0

JONSWAP sea spectrum with the peak parameter of 3.3 is to be considered for coastal waters.

1.2 The following adverse condition is to be applied to ships defined by the following threshold value of ship size.

Ship length, m	Significant wave height h_s , m	Peak wave period T_p , s	Mean wind speed V_w , m/s
Less than 200	4.0	7.0 to 15.0	15.7
$200 \leq L_{pp} \leq 250$	Parameters linearly interpolated depending on ship's length		
More than $L_{pp} = 250$	Refer to paragraph 1.1		

2 Applicability

2.1 The guidelines are to be applied in the case of all new ships of types as listed in Table 1.1 of the annex required to comply with the requirements on CO₂ emission of the Rules.

2.2 Notwithstanding the above, the guidelines are not to be applied to ships with un-conventional propulsion systems, such as pod propulsion.

2.3 The guidelines are intended for ships in unrestricted navigation.

3 Assessment procedure

3.1 The assessment can be carried out at two different levels as listed below:

- .1 minimum power lines assessment; and
- .2 simplified assessment.

3.2 The ship is to be considered to have sufficient power to maintain the manoeuvrability in adverse conditions if it fulfils one of these assessment levels.

4 Assessment level 1 – minimum power lines assessment

4.1 If the ship under consideration has installed power not less than the power defined by the minimum power line for the specific ship type, the ship is to be considered to have sufficient power to maintain the manoeuvrability in adverse conditions.

4.2 The minimum power lines for the different types of ships are provided in the annex.

5 Assessment level 2 – simplified assessment

5.1 The methodology for the simplified assessment is provided in the annex.

5.2 If the ship under consideration fulfils the requirements as defined in the simplified assessment, the ship is to be considered to have sufficient power to maintain the manoeuvrability in adverse conditions.

6 Documentation

6.1 Test documentation is to include at least, but not be limited to, a:

- .1 description of the ship's main particulars;
- .2 description of the ship's relevant manoeuvring and propulsion systems;
- .3 description of the assessment level used and results; and
- .4 description of the test method(s) used with references, if applicable.

Annex Assessment Procedures to Maintain the Maneuverability under Adverse Conditions

1 Minimum power lines

1.1 The minimum power line values of total installed *MCR*, in kW, for different types of ships are to be calculated as follows:

$$\text{Minimum Power Line Value} = a \times (DWT) + b$$

where: *DWT* is the deadweight of the ship in metric tons; and

a and *b* are the parameters given in Table 1.1 for tankers, bulk carriers and combination carriers.

**Parameters *a* and *b* for determination of the minimum power line values
for the different ship types**

Table 1.1

Ship type	<i>a</i>	<i>b</i>
Bulk Carrier which DWT is less than 145,000	0.0763	3374.3
Bulk Carrier which DWT is 145,000 and over	0.0490	7329.0
Tanker	0.0652	5960.2
Combination Carrier	See tanker above	

1.2 The total installed *MCR* of all main propulsion engines is not to be less than the minimum power line value, where *MCR* is the value specified on the EIAPP Certificate.

2 Simplified assessment

2.1 The simplified assessment procedure is based on the principle that, if the ship has sufficient installed power to move with a certain advance speed in head waves and wind, the ship will also be able to keep course in waves and wind from any other direction. The minimum ship speed of advance in head waves and wind is thus selected depending on ship design, in such a way that the fulfilment of the ship speed of advance requirements means fulfilment of course-keeping requirements. For example, ships with larger rudder areas will be able to keep course even if the engine is less powerful; similarly, ships with a larger lateral windage area will require more power to keep course than ships with a smaller windage area.

2.2 The simplification in this procedure is that only the equation of steady motion in longitudinal direction is considered; the requirements of course-keeping in wind and waves are taken into account indirectly, by adjusting the required ship speed of advance in head wind and waves.

2.3 The assessment procedure consists of two steps:

- .1 definition of the required advance speed in head wind and waves, ensuring course-keeping in all wave and wind directions; and
- .2 assessment whether the installed power is sufficient to achieve the required advance speed in head wind and waves.

Definition of required ship speed of advance

2.4 The required ship advance speed through the water in head wind and waves, V_s , is set to the larger of:

- .1 minimum navigational speed, V_{nav} ; or
- .2 minimum course-keeping speed V_{ck} .

2.5 The minimum navigational speed, V_{nav} , facilitates leaving coastal area within a sufficient time before the storm escalates, to reduce navigational risk and risk of excessive motions in waves due to unfavourable heading with respect to wind and waves. The minimum navigational speed is set to 4.0 knots.

2.6 The minimum course-keeping speed in the simplified assessment, V_{ck} , is selected to facilitate course-keeping of the ships in waves and wind from all directions. This speed is defined on the basis of the reference course-keeping speed $V_{ck,ref}$ related to ships with the rudder area A_R equal to 0.9% of the submerged lateral area corrected for breadth effect, and an adjustment factor taking into account the actual rudder area:

$$V_{ck} = V_{ck,ref} - 10.0 \times (A_{R\%} - 0.9) \quad (1)$$

where: V_{ck} is the minimum course-keeping speed, in knots;

$V_{ck,ref}$ is the reference course-keeping speed, in knots;

$A_{R\%}$ is the actual rudder area, A_R , as percentage of the submerged lateral area of the ship corrected for breadth effect, $A_{LS,cor}$, calculated as $A_{R\%} = A_R / A_{LS,cor} \times 100\%$.

The submerged lateral area corrected for breadth effect is calculated as $A_{LS,cor} = L_{pp} T_m (1.0 + 25.0 (B_{wl} / L_{pp})^2)$, where L_{pp} is the length between perpendiculars in m, B_{wl} is the water line breadth in m, T_m is the draft a midship in m. In case of high-lift rudders or other alternative steering devices, the equivalent rudder area to the conventional rudder area is to be used.

2.7 The reference course-keeping speed $V_{ck,ref}$ for bulk carriers, tankers and combination carriers is defined, depending on the ratio A_{FW} / A_{LW} of the frontal windage area, A_{FW} , to the lateral windage area, A_{LW} , as follows:

- .1 9.0 knots for $A_{FW} / A_{LW} \leq 0.1$, and 4.0 knots for $A_{FW} / A_{LW} \geq 0.40$; and
- .2 linearly interpolated between 0.1 and 0.4 for intermediate values of A_{FW} / A_{LW} .

Procedure of assessment of installed power

2.8 The assessment is to be performed in maximum draught conditions at the required ship speed of advance, V_s , defined above. The principle of the assessment is that the required propeller thrust, T in N, defined from the sum of bare hull resistance in calm water R_{cw} , resistance due to appendages R_{app} , aerodynamic resistance R_{air} , and added resistance in waves R_{aw} , can be provided by the ship's propulsion system, taking into account the thrust deduction factor t :

$$T = (R_{cw} + R_{air} + R_{aw} + R_{app}) / (1 - t) \quad (2)$$

2.9 The calm-water resistance for bulk carriers, tankers and combination carriers can be calculated neglecting the wave-making resistance as:

$$R_{cw} = (1 + k) C_F \frac{1}{2} \rho S V_s^2$$

where: k is the form factor, $C_F = \frac{0.075}{(\log_{10} Re - 2)^2}$ is the frictional resistance coefficient, $Re = \frac{V_s L_{pp}}{\nu}$ is the Reynolds

number, ρ is water density in kg/m^3 , S is the wetted area of the bare hull in m^2 , V_s is the ship advance speed in m/s , ν is the kinematic viscosity of water in m^2/s .

2.10 The form factor k is to be obtained from model tests. Where model tests are not available the empirical formula below may be used:

$$k = -0.095 + 25.6 \frac{C_B}{(L_{pp} / B_{wl})^2 \sqrt{B_{wl} / T_m}} \quad (3)$$

where: C_B is the block coefficient based on L_{pp} .

2.11 Aerodynamic resistance can be calculated as:

$$R_{air} = C_{air} \frac{1}{2} \rho_a A_F V_{w,rel}^2$$

where: C_{air} is the aerodynamic resistance coefficient, ρ_a is the density of air in kg/m^3 , A_F is the frontal windage area of the hull and superstructure in m^2 , $V_{w,rel}$ is the relative wind speed in m/s , defined by the adverse conditions in paragraph 1.1 of the interim guidelines, V_w , added to the ship advance speed, V_s . The coefficient C_{air} can be obtained from model tests or empirical data. If none of the above is available, the value 1.0 is to be assumed.

2.12 The added resistance in waves, R_{aw} , defined by the adverse conditions and wave spectrum in paragraph 1 of the interim guidelines, is calculated as:

$$R_{aw} = 2 \int_0^\infty \frac{R_{aw}(V_s, \omega)}{\zeta_a^2} S_{\zeta\zeta}(\omega) d\omega \quad (4)$$

where: $R_{aw}(V_s, \omega) / \zeta_a^2$ is the quadratic transfer function of the added resistance, depending on the advance speed V_s in m/s , wave frequency ω in rad/s , the wave amplitude, ζ_a in m and the wave spectrum $S_{\zeta\zeta}$ in m^2/s . The quadratic transfer function of the added resistance can be obtained from the added resistance test in regular waves at the required ship advance speed V_s as per ITTC procedures 7.5-02 07-02.1 and 7.5-02 07-02.2, or from equivalent method verified by the Administration.

2.13 The thrust deduction factor t can be obtained either from model tests or empirical formula. Default conservative estimate is:

$$t = 0.7w$$

where: w is the wake fraction. Wake fraction w can be obtained from model tests or empirical formula; default conservative estimates are given in Table 2.13.

Recommended values for wake fraction w

Table 2.13

Block coefficient	One propeller	Two propellers
0.5	0.14	0.15
0.6	0.23	0.17
0.7	0.29	0.19
0.8 and above	0.35	0.23

2.14 The required advance coefficient of the propeller is found from the equation:

$$T = \rho U_a^2 D_p^2 K_T(J) / J^2 \quad (5)$$

where: D_p is the propeller diameter, $K_T(J)$ is the open water propeller thrust coefficient, $J = U_a / n D_p$ and $U_a = V_s(1 - w)$. J can be found from the curve of $K_T(J)/J^2$.

2.15 The required rotation rate of the propeller, n , in revolutions per second, is found from the relation:

$$n = U_a / (J D_p) \quad (6)$$

2.16 The required delivered power to the propeller at this rotation rate n , P_D in watt, is then defined from the relation:

$$P_D = 2\pi\rho n^3 D_p^5 K_Q(J) \quad (7)$$

where: $K_Q(J)$ is the open water propeller torque coefficient curve. Relative rotative efficiency is assumed to be close to 1.0.

2.17 For diesel engines, the available power is limited because of the torque-speed limitation of the engine, $Q \leq Q_{max}(n)$, where $Q_{max}(n)$ is the maximum torque that the engine can deliver at the given propeller rotation rate n . Therefore, the required minimum installed MCR is calculated taking into account:

- .1 torque-speed limitation curve of the engine which is specified by the engine manufacturer; and
- .2 transmission efficiency η_s which is to be assumed 0.98 for aft engine and 0.97 for midship engine, unless exact measurements are available.

Appendix 4 Measurement of Ambient Noise from Ships

1 General provisions

- (1) This Appendix is intended to provide measurement procedures and technical requirements for ambient noise from ships as specified in 2.5.5 and 4.3.5 of the Rules.
- (2) This Appendix is for measurement of ship ambient noise, to reduce the effect of ambient noise on the banks of waterways and harbor areas.
- (3) If a ship has undergone a major conversion which may affect ambient noise, re-measurement is to be carried out and confirmed.

2 Measuring instruments

- (1) Measuring instruments include precision sound level meters, microphones, sound calibrators and windscreen, etc.
- (2) Measuring instruments are to comply with the following requirements:
 - ① free field microphones are to comply with the requirements of IEC 61094;
 - ② sound level meters are to comply with the level 1 requirements in IEC 61672-1: 2002;
 - ③ sound calibrators are to comply with the level 1 requirements in IEC 60942:2003;
 - ④ filters are to comply with the level 1 requirements of IEC 61260:1995.
- (3) All measuring instruments and calibrators are to be verified by nationally recognized metrological verification institutions and are within the period of validity.

3 Measurement conditions

3.1 Measurement site

- (1) The surroundings of the microphone up to 30 m are to be free of large, sound-reflecting objects like barriers, hills, rocks, bridges or buildings, etc. The area between the vessel being measured and the measurement microphone is to be open water or the ground without sound absorbing coverings (e.g. grass, snow), free from any person or obstacle.
- (2) Impacts of other noise sources are to be avoided during measurement, e.g. noise due to wind, the amplifier of the measuring instruments, electromagnetic interference or other external sound sources.
- (3) At the test course, the depth of water is to be sufficient for normal operation of the vessel.

3.2 Meteorological conditions

- (1) During measurement, wind velocity is not to exceed 7 m/s; measurement is to be avoided in conditions of rain or snow.
- (2) Where there is prominent air flow, a windscreen is to be used to effectively avoid the impact on the measurement results.

3.3 Conditions of ships navigating in course or operating in harbors

- (1) Ships are to be measured in typical navigational or harbor operational conditions.
- (2) The main engines, generators and engine room ventilators, etc. are to run at a design output power for normal navigational or harbor operational conditions. All machinery installations that may be probably used at the same time during normal navigation or during operation in harbors are to be started simultaneously.

3.4 Background noise

- (1) Background noise generated by external sound sources is not to affect the noise level at measurement positions.
- (2) Background noise is at least to be 6 dB(A) lower than the measured radiated noise from ships.
- (3) The effect of background noise on ambient noise is to be corrected according to Table 3.4.1.

Effect of background noise on ambient noise

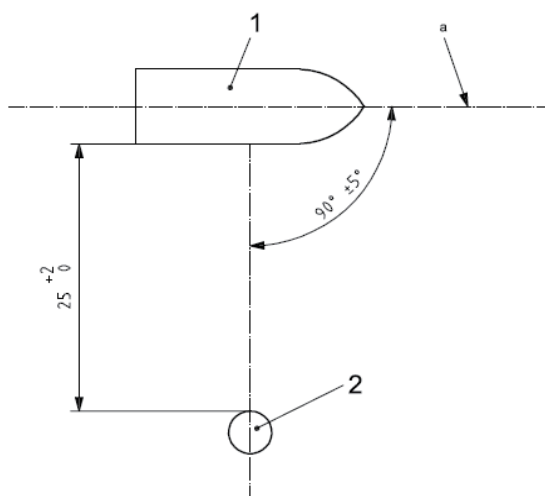
Table 3.4.1

Difference between the measured ambient noise and background noise, in dB	Correction to be applied to the measured ambient noise, in dB
≥ 10	0
6 to 9	-1

4 Measurement procedures

4.1 Measurement preparation

- (1) The microphone is to be positioned 3.5 ± 0.5 m above the water surface and, if mounted on a solid surface, is to be positioned at least 1.2 m above that surface. The microphone is to be positioned within ± 0.5 m of the edge of the surface above which it is mounted.
- (2) The microphone may be placed on the shore, on a boat, on a remote buoy or other suitable platform. The microphone is to be oriented to the path of the ship in accordance with the manufacturer's recommendation.
- (3) When the vessel passes the point right in front of the microphone, the reference distance between the microphone and the ship is to be 25 ± 2 m. Correction is to be made if there's deviation from this distance.
- (4) For a ship operating in a harbor, the microphones are to be placed 25 ± 2 m from the ship and at several points around the ship.



1—ship being measured 2—microphone a—ship course line

Figure 4.1.1 Position of the microphone and test course

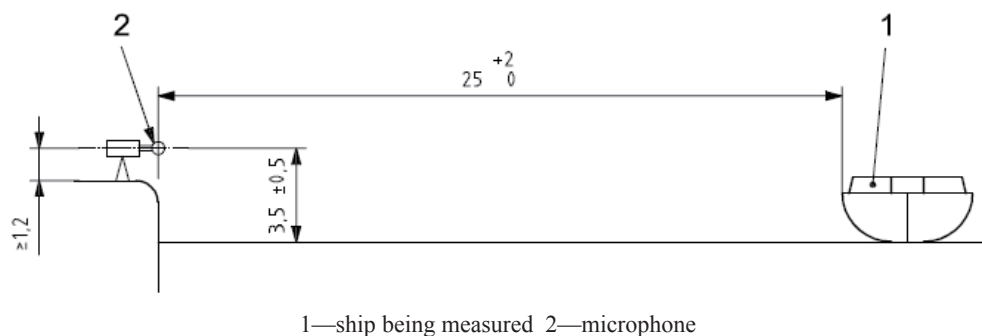


Figure 4.1.2 Microphone position and heights

4.2 Measurement procedures for ships navigating in course or operating in harbors

- (1) The heading of the ship is to be a straight line as far as possible during measurement, and the test course is to be followed by the ship being measured as required and its heading is to be recorded.
- (2) The vertical foot is obtained from the trajectory of the microphone to ship course. The ship being measured is to be in a condition as specified when at a distance from the microphone. Recording of data is to be started when the distance between the bow and the vertical foot is two times the ship length and recording is to be stopped when the distance between the stern and the vertical foot is two times the ship length.
- (3) Analysis is to be carried out on the data of maximum AS-weighted sound pressure level recorded by the microphone which are to be used as a sample as a whole .
- (4) At least two measurements are to be made for each side of the ship and the average value is to be taken. The difference between the measurement results is not to be greater than 3dB.
- (5) If for the ship being measured, the reference distance of 25 m cannot be ensured, the measured maximum AS-weighted sound pressure level is to be corrected according to the following formula:

$$L_{pAS\max,25} = L_{pAS\max,d} + 20\lg(d/25)$$

Where: $L_{pAS\max,25}$ — The converted maximum AS-weighted sound pressure level when the distance between the microphone and the ship is 25m, in dB;

$L_{pAS\max,d}$ — The measured maximum AS-weighted sound pressure level measured at a distance d, in dB;

d — During measurement, the actual distance between the microphone and the side of the vessel being measured, in m.