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GUIDELINES ON CALCULATION AND VERIFICATION OF THE ENERGY EFFICIENCY DESIGN INDEX (EEDI) OF INTERNATIONAL SEA-GOING SHIPS

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Chapter 2 Attained EEDI Calculation

2.3 Definition and selection of parameters in Attained EEDI calculation formula

2.3.1 Carbon conversion factor (C_F)

2.3.1.1 C_F is a non-dimensional conversion factor between fuel consumption and CO_2 emission based on carbon content, measured int-CO_2/t-Fuel. The subscripts *MEi* and *AEi* refer to the main and auxiliary engine(s) respectively. C_F is the carbon conversion factor corresponding 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 2.3.1.1:

Carbon Conversion Factor C_F **Table 2.3.1.1**

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
8. Ethane		46400	0.7989	2.927

2.3.1.2 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.

(1) The fuel availability of gas fuel is to be calculated 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;

Normal density, Lower Calorific Value and filling rate for tanks of different kinds of fuel are shown

inTable 2.3.1.2.

Parameter Default Values **Table 2.3.1.2**

Type of fuel	Density (kg/m^3)	Lower Calorific Value (kJ/kg)	Filling rate for tanks
Diesel/Gas Oil	900	42700	0.98
Heavy Fuel Oil	991	40200	0.98
Liquefied Natural Gas (LNG)	450	48000	0.95*

*subject to verification of tank filling limit

(2) 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.

(3) 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:

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

2.3.4 Deadweight (DWT)

2.3.4.1 Deadweight means the difference in tonnes between the displacement of a ship in water of relative density of 1,025 kg/m^3 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. In the case of a new ship with multiple load line certificates or with a load line certificate containing multiple summer load lines, the maximum summer draught should be used to calculate and verify the required and Attained EEDI.

2.3.7 Specific Fuel Consumption (SFC)

2.3.7.1 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.

（1）In case *SFC* is corrected to ISO standard reference conditions with standard LCV of LFO (41,200 kJ/kg), *SFC* and the conversion factor, C_F (3.151), are to correspond to LFO;

（2）In case *SFC* is corrected to ISO standard reference conditions with standard LCV of MDO (42,700kJ/kg), *SFC* and the conversion factor, C_F (3.206), are to correspond to MDO.

2.4 Mandatory Reporting of Attained EEDI Values and Related Information

2.4.1 In accordance with regulation 22.3 of MARPOL Annex VI, for each ship subject to regulation 24, the Administration or any organization duly authorized by it is to report the required and attained EEDI values and relevant information taking into account this Section via electronic communication.

2.4.2 Information to be reported are as follows:

(1) applicable EEDI phase (e.g. Phase 1, Phase 2, etc.);
(2) identification number (IMO Secretariat use only);
(3) ship type;
(4) common commercial size reference (see Note (3) in Table 1), if available;
(5) DWT or GT (as appropriate);
(6) year of delivery;
(7) required EEDI value;
(8) attained EEDI value;

(9) dimensional parameters (length Lpp (m), breadth Bs (m), and draught (m));
(10) V_{ref} (knots) and P_{ME} (kW);
(11) use of innovative technologies (4th and 5th terms in the EEDI equation, if applicable);
(12) short statement describing the principal design elements or changes employed to achieve the attained EEDI (as appropriate), if available;
(13) type of fuel used in the calculation of the attained EEDI, and for dual-fuel engines, the f_{DFgas} ratio; and
(14) ice class designation (if applicable).

2.4.3 The information in paragraph 2.4.2 is not required to be reported for ships for which the required and attained EEDI values had been already reported to IMO.

2.4.4 A standardized reporting format for Mandatory Reporting of Attained EEDI Values and Related Information is presented in Table 2.4.4.