where,

$V_{S,EEDI,}$ is the sea trial service speed under the EEDI draught; and

$P_{S,EEDI}$ is power of the main engine corresponding to $V_{S,EEDI}$.

2.2.3.4 For containerships, bulk carriers or tankers not falling into the scope of the EEDI requirement but whose sea trial results, which may have been calibrated by the tank test, under the design load draught and sea condition as specified in paragraph 2.2.2 of the EEDI Calculation Guidelines are included in the sea trial report, the ship speed V_{ref} may be obtained from the sea trial report:

$$V_{ref} = k^{\frac{1}{3}} \times \left(\frac{DWT_{S,service}}{Capacity}\right)^{\frac{2}{9}} \times V_{S,service} \times \left[\frac{P_{ME}}{P_{S,service}}\right]^{\frac{1}{3}} \quad \text{[knot]}$$

where,

$V_{S,service}$ is the sea trial service speed under the design load draught;

$DWT_{S,service}$ is the deadweight under the design load draught;

$P_{S,service}$ is the power of the main engine corresponding to $V_{S,service}$;

k is the scale coefficient, which should be:

.1 0.95 for containerships with 120,000 DWT or less;

.2 0.93 for containerships with more than 120,000 DWT;

.3 0.97 for bulk carrier with 200,000 DWT or less;

.4 1.00 for bulk carrier with more than 200,000 DWT;

.5 0.97 for tanker with 100,000 DWT or less; and

.6 1.00 for tanker with more than 100,000 DWT.

2.2.3.5 In cases where the speed-power curve is not available or the sea trial report does not contain the EEDI or design load draught condition, the ship speed V_{ref} can be approximated by $V_{ref,app}$ to be obtained from statistical mean of distribution of ship speed and engine power, as defined below:

$$V_{ref,app} = (V_{ref,avg} - m_V) \times \left[\frac{\sum P_{ME}}{0.75 \times MCR_{avg}}\right]^{\frac{1}{3}} \quad \text{[knot]}$$

For LNG carriers having diesel electric propulsion system and cruise passenger ship having non-conventional propulsion,

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

where,

$V_{ref,avg}$ is a statistical mean of distribution of ship speed in given ship type and ship size, to be calculated as follows:

$$V_{ref,avg} = A \times B^C$$

where

A, B and C are the parameters given in the appendix;

m_V is a performance margin of a ship, which should be 5% of $V_{ref,avg}$ or one knot, whichever is lower; and

MCR_{avg} is a statistical mean of distribution of MCRs for main engines and MPP_{avg} is a statistical mean of distribution of MPPs for motors in given ship type and ship size, to be calculated as follows:

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

where

D, E and F are the parameters given in the appendix;

In cases where the overridable Shaft / Engine Power Limitation is installed, the ship speed V_{ref} approximated by $V_{ref,app}$ should be calculated as follows:

$$V_{ref,app} = (V_{ref,avg} - m_V) \times \left[\frac{\sum P_{ME}}{0.75 \times MCR_{avg}}\right]^{\frac{1}{3}} \quad \text{[knot]}$$

For LNG carriers having diesel electric propulsion system and cruise passenger ship having non-conventional propulsion, the ship speed V_{ref} approximated by $V_{ref,app}$ should be calculated as follows:

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

2.2.3.6 Notwithstanding the above, in cases where the energy saving device* is installed, the effect of the device may be reflected in the ship speed V_{ref} with the approval of the verifier, based on the following methods in accordance with defined quality and technical standards:

.1 sea trials after installation of the device; and/or

.2 dedicated model tests; and/or

.3 numerical calculations.

* Devices that shift the power curve, which results in the change of P_P and V_{ref}, as specified in MEPC.1/Circ.815 on *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI*.

2.2.4 *SFC*; Certified specific fuel consumption

In cases where overridable Shaft / Engine Power Limitation is installed, the *SFC* corresponding to the P_{ME} should be interpolated by using *SFC*s listed in an applicable test report included in an approved NO_X Technical File of the main engine as defined in paragraph 1.3.15 of the NO_X Technical Code.

Notwithstanding the above, the *SFC* specified by the manufacturer or confirmed by the verifier may be used.

For those engines which do not have a test report included in the NO_X Technical File and which do not have the *SFC* specified by the manufacturer or confirmed by the verifier, the *SFC* can be approximated by SFC_{app} defined as follows:

$$SFC_{ME,app} = 190\ [g/kWh]$$

$$SFC_{AE,app} = 215\ [g/kWh]$$

2.2.5 C_F ; Conversion factor between fuel consumption and CO_2 emission

For those engines which do not have a test report included in the NO_X Technical File and which do not have the *SFC* specified by the manufacturer, the C_F corresponding to SFC_{app} should be defined as follows:

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

Otherwise, paragraph 2.2.1 of the EEDI Calculation Guidelines applies.

2.2.6 Correction factor for ro-ro cargo and ro-ro passenger ships (f_{jRoRo})

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

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

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

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

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

and the exponents 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

2.2.7 Cubic capacity correction factor for ro-ro cargo ships (vehicle carrier) ($f_{cVEHICLE}$)

For ro-ro cargo ships (vehicle carrier) having a DWT/GT ratio of less than 0.35, the following cubic capacity correction factor, $f_{cVEHICLE}$, should apply:

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

Where DWT is the capacity and GT is the gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, annex I, regulation 3.

APPENDIX

Parameters to calculate $V_{ref,avg}$

Ship type	A	B	C
Bulk carrier	10.6585	DWT of the ship	0.02706
Gas carrier	7.4462	DWT of the ship	0.07604
Tanker	8.1358	DWT of the ship	0.05383
Containership	3.2395	DWT of the ship where DWT ≤ 80,000 80,000 where DWT > 80,000	0.18294
General cargo ship	2.4538	DWT of the ship	0.18832
Refrigerated cargo carrier	1.0600	DWT of the ship	0.31518
Combination carrier	8.1391	DWT of the ship	0.05378
LNG carrier	11.0536	DWT of the ship	0.05030
Ro-ro cargo ship (vehicle carrier)	16.6773	DWT of the ship	0.01802
Ro-ro cargo ship	8.0793	DWT of the ship	0.09123
Ro-ro passenger ship	4.1140	DWT of the ship	0.19863
Cruise passenger ship having non-conventional propulsion	5.1240	GT of the ship	0.12714

Parameters to calculate MCR_{avg} or MPP_{avg} (= D x E^F)

Ship type	D	E	F
Bulk carrier	23.7510	DWT of the ship	0.54087
Gas carrier	21.4704	DWT of the ship	0.59522
Tanker	22.8415	DWT of the ship	0.55826
Containership	0.5042	DWT of the ship where DWT ≤ 95,000 95,000 where DWT > 95,000	1.03046
General cargo ship	0.8816	DWT of the ship	0.92050
Refrigerated cargo carrier	0.0272	DWT of the ship	1.38634
Combination carrier	22.8536	DWT of the ship	0.55820
LNG carrier	20.7096	DWT of the ship	0.63477
Ro-ro cargo ship (vehicle carrier)	262.7693	DWT of the ship	0.39973
Ro-ro cargo ship	37.7708	DWT of the ship	0.63450
Ro-ro passenger ship	9.1338	DWT of the ship	0.91116
Cruise passenger ship having non-conventional propulsion	1.3550	GT of the ship	0.88664

Calculation of parameters to calculate $V_{ref,avg}$ and MCR_{avg}

Data sources

1 IHS Fairplay (IHSF) database with the following conditions are used.

Ship type	Ship size	Delivered period	Type of propulsion systems	Population
Bulk carrier	≥ 10,000 DWT	From 1 January 1999 to 1 January 2009	Conventional	2,433
Gas carrier	≥ 2,000 DWT		Conventional	292
Tanker	≥ 4,000 DWT		Conventional	3,345
Containership	≥ 10,000 DWT		Conventional	2,185
General cargo ship	≥ 3,000 DWT		Conventional	1,673
Refrigerated cargo carrier	≥ 3,000 DWT		Conventional	53
Combination carrier	≥ 4,000 DWT		Conventional	3,351
LNG carrier	≥ 10,000 DWT		Conventional, Non-conventional	185
Ro-ro cargo ship (vehicle carrier)	≥ 10,000 DWT		Conventional	301
Ro-ro cargo ship	≥ 1,000 DWT	From 1 January 1998 to 31 December 2010	Conventional	188
Ro-ro passenger ship	≥ 250 DWT		Conventional	350
Cruise passenger ship having non-conventional propulsion	≥ 25,000 GT	From 1 January 1999 to 1 January 2009	Non-conventional	93

2 Data sets with blank/zero "Service speed", "Capacity" and/or Total kW of M/E" are removed.

3 Ship type is in accordance with table 1 and table 2 of resolution MEPC.231(65) on *2013 Guidelines for calculation of reference lines for use with the Energy Efficiency Design Index (EEDI)*. However, "Gas carrier" does not include "LNG carrier". Parameters for "LNG carrier" are given separately.

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