

## ANNEX 1

### DRAFT GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX FOR NEW SHIPS

#### 1 Definitions

Option 1: [For the purpose of these Guidelines, the definitions in "DRAFT REGULATIONS ON ENERGY EFFICIENCY FOR SHIPS" (annex 1 to document MEPC 61/WP.10) apply.]

or

Option 2: [For the purpose of these Guidelines, the following definitions should apply:

.1	Passenger ship	A ship which carries more than 12 passengers
.2	Bulk carrier	A ship which is intended primarily to carry dry cargo in bulk, including such types as ore carrier as defined in SOLAS chapter XII, regulation 1, but excluding combination carrier
.3	Gas tanker	A cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas
.4	Tanker	An oil tanker as defined in MARPOL Annex I, regulation 1 or a chemical tanker and a NLS tanker as defined in MARPOL Annex II, regulation 1
.5	Containership	A ship designed exclusively for the carriage of containers in holds and on deck
.6	Ro-ro cargo ship: Vehicle carrier	A multi deck ro-ro cargo ship designed for the carriage of empty cars and trucks
.7	Ro-ro cargo ship: Volume carrier	A ship with a deadweight per lane-metre less than 4 <sup>1</sup> tons/m, designed for the carriage of cargo transportation units
.8	Ro-ro cargo ship: Weight carrier	A ship with a deadweight per lane-metre of 4 <sup>1</sup> tons/m or above, designed for the carriage of cargo transportation units
.9	General cargo ship	A ship with a multi-deck or single-deck hull designed primarily for the carriage of general cargo
.10	Ro-ro passenger ship	A passenger ship with ro-ro spaces or special category spaces
.11	Refrigerated cargo carrier	A ship designed exclusively for the carriage of refrigerated cargoes in holds
.12	Combination carrier	A ship designed to load 100% deadweight with either liquid or dry cargo in bulk

Ships falling within more than one of the ship types should be considered as being the ship type with the lower reference line.] (end of option 2)

<sup>1</sup> The value should be further investigated during the period of voluntary use of the EEDI.

Definitions of ro-ro cargo ship group [mentioned in paragraphs 1.6 to 1.8] [mentioned in regulations 1.12 to 1.14 of Draft Regulations on Energy Efficiency for Ships (annex 1, MEPC 61/WP.10)] may be reconsidered before the application of Required EEDI (regulation 4 of Draft Regulations on Energy Efficiency for Ships (annex 1, MEPC 61/WP.10) to those ship types is determined.

Comment of CG coordinator 1: Simplification of definitions

As a proposal from CG coordinator, both Option 1 and Option 2 are put in [square brackets] at this time.

If MARPOL ANNEX VI will be adopted at MEPC, then Option 2 will be removed to be simplification of the guidelines. In that case, the sentence, "Ships falling within more than ... reference line", is also will be removed, since Regulation 4.4 of annex 1 to MEPC 61/WP.10 regulates same point.

## 2 Energy Efficiency Design Index (EEDI)

The attained new ship Energy Efficiency Design Index (EEDI) is a measure of ships energy efficiency (g/t\*nm) and calculated by the following formula:

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

\* If part of the Normal Maximum Sea Load is provided by shaft generators,  $SFC_{ME}$  may – for that part of the power – be used instead of  $SFC_{AE}$

**Note:** This formula may not be able to apply to diesel-electric propulsion, turbine propulsion or hybrid propulsion system.

Where:

.1  $C_F$  is a non-dimensional conversion factor between fuel consumption measured in g and CO<sub>2</sub> emission also measured in g based on carbon content. The subscripts  $ME_i$  and  $AE_i$  refer to the main and auxiliary engine(s) respectively.  $C_F$  corresponds to the fuel used when determining  $SFC$  listed in the applicable test report included in a Technical File as defined in paragraph 1.3.15 of NO<sub>x</sub> Technical Code ("test report included in a NO<sub>x</sub> technical file" hereafter). The value of  $C_F$  is as follows:

Type of fuel	Reference	Carbon content	$C_F$ (t-CO <sub>2</sub> /t-Fuel)
1 Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	0.8744	3.206
2 Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	0.8594	3.151
3 Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	0.8493	3.114
4 Liquefied Petroleum Gas (LPG)	Propane	0.8182	3.000
	Butane	0.8264	3.030
5 Liquefied Natural Gas (LNG)		0.7500	2.750

- .2  $V_{ref}$  is the ship speed, measured in nautical miles per hour (knot), on deep water in the condition corresponding to the *Capacity* as defined in paragraph 2.3.1 and 2.3.3 (in case of passenger ships and ro-ro passenger ships, this condition should be summer load draught as provided in paragraph 2.4) at the shaft power of the engine(s) as defined in paragraph 2.5 and assuming the weather is calm with no wind and no waves.
- .3 *Capacity* is defined as follows:
- .1 For bulk carriers, tankers, gas tankers, ro-ro cargo, general cargo ships, refrigerated cargo carrier and combination carriers, deadweight should be used as *Capacity*.
  - .2 For passenger ships and ro-ro passenger ships, gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, Annex I, regulation 3 should be used as *Capacity*.
  - .3 For containerships, 65% of the deadweight should be used as *Capacity*.
- .4 *Deadweight* means the difference in tonnes between the displacement of a ship in water of relative density of 1,025 kg/m<sup>3</sup> at the summer load draught and the lightweight of the ship. The summer load draught should be taken as the maximum summer draught as certified in the stability booklet approved by the administration or an organization recognized by it.
- .5  $P$  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 ( $^{n_{ME}}$ ). (See the diagram in Appendix 1.)

- .1  $P_{ME(i)}$  is 75% of the rated installed power ( $MCR^2$ ) for each main engine ( $i$ ) after having deducted any installed shaft generator(s):

$$P_{ME(i)} = 0.75 \times (MCR_{MEi} - P_{PTOi})$$

[Irrespective of the maximum output of an installed shaft generator, the maximum allowable deduction of 75% of  $P_{PTOi}$  within the calculation of  $P_{ME(i)}$  is to be no more than  $P_{AE}$  as defined in paragraph 2.5.6.

Where power from the shaft generator is being used for cargo loads under normal seagoing conditions, (e.g., reefer containers) then these should not be included in the calculation.

For specialized designs, where an engine is installed with a higher power output than the shaft(s) and propeller(s) are capable of delivering, then the value of  $P_{ME(i)}$  used for EEDI purposes is 75% of the power that the propulsion system is capable of delivering through the propulsor.]

<sup>2</sup> The value of MCR specified on the EIAPP certificate should be used for calculation. If the main engines are not required to have an EIAPP certificate, the MCR on the nameplate should be used.

(Alternative proposal from BIMCO)

[Where power from the shaft generator is being used for cargo loads under normal seagoing conditions, (e.g., reefer containers) then these should not be included in the calculation.

$P_{ME(i)}$  is in all circumstances to be no less than 75% of the power that the propulsion system is capable of delivering through the propulsor.]

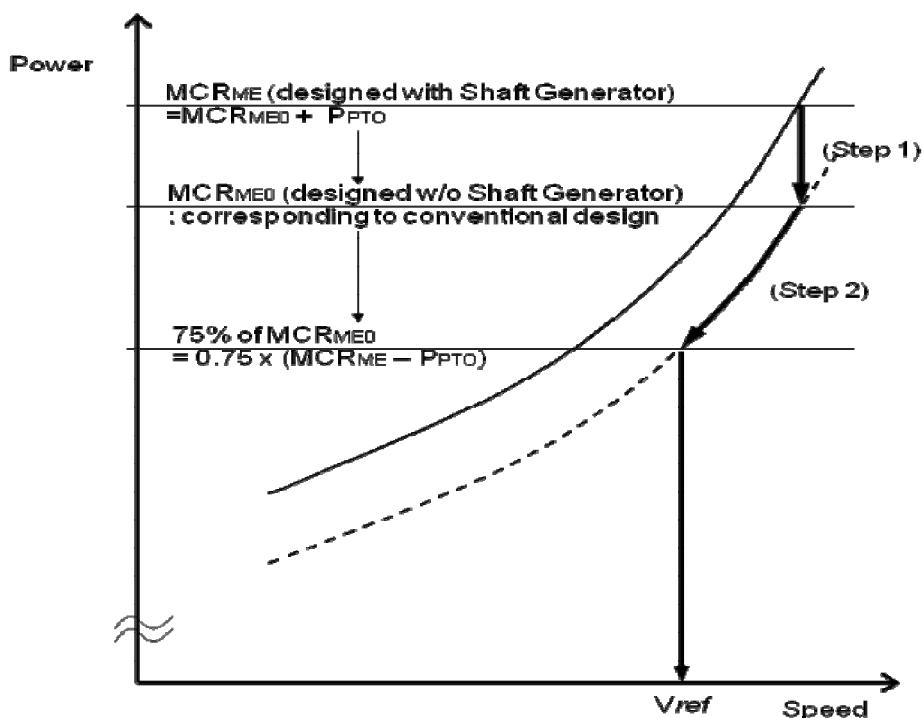
Comment of CG coordinator 2: Definition of  $P_{ME}$

BIMCO proposed to delete the sentence "Irrespective ... as defined in paragraph 2.5.6." and to replace the sentence "For specialized designs, where for example, an engine is installed with a higher power output than the shaft(s) and propeller(s) are capable of delivering, then the value of  $P_{ME(i)}$  used for EEDI purposes is to be no less than 75% of the power that the propulsion system is capable of delivering through the propulsor" by a sentence " $P_{ME(i)}$  is in all circumstances to be no less than 75% of the power that the propulsion system is capable of delivering through the propulsor."

China also proposed deleting the sentence "For specialized designs ... through the propulsor.". On the other hand, ICS supports to retain these sentences.

CG Coordinator considers that these issues should be discussed at MEPC 62.

The following figure gives guidance for determination of  $P_{ME(i)}$ :



- .2  $P_{PTO(i)}$  is 75% output of each shaft generator installed divided by the relevant efficiency of that shaft generator.
- .3  $P_{PTI(i)}$  is 75% of the rated power consumption of each shaft motor divided by the weighted averaged efficiency of the generator(s).

In case of combined PTI/PTO, the normal operational mode at sea will determine which of these to be used in the calculation.

**Note:** 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.

- .4  $P_{eff(i)}$  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 dual-fuel engine or a number of engines, the  $CF_{ME}$  and  $SFC_{ME}$  should be the power weighted average of all the main engines.

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

- .6  $P_{AE}$  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, maintaining cargo, e.g., reefers and cargo hold fans, in the condition where the ship engaged in voyage at the speed ( $V_{ref}$ ) under the condition as mentioned in paragraph 2.2.

- .1 For ships with a main engine power of 10,000 kW or above,  $P_{AE}$  is defined as:

$$P_{AE(MCRME \geq 10000KW)} = \left( 0.025 \times \sum_{i=1}^{nME} MCR_{MEi} \right) + 250$$

- .2 For ships with a main engine power below 10,000 kW,  $P_{AE}$  is defined as:

$$P_{AE(MCRME < 10000KW)} = 0.05 \times \sum_{i=1}^{nME} MCR_{MEi}$$

- .3 For ship where the  $P_{AE}$  value calculated by paragraphs 2.5.6.1 or 2.5.6.2 is significantly different from the total power used at normal seagoing, e.g., in cases of passenger ships (see NOTE under the formula of EEDI), the  $P_{AE}$  value should be estimated by the consumed electric power (excluding propulsion) in conditions when the ship is engaged in a voyage at reference speed ( $V_{ref}$ )

as given in the electric power table<sup>3</sup>, divided by the average efficiency of the generator(s) weighted by power (see appendix 2).

- .6  $V_{ref}$ , Capacity and  $P$  should be consistent with each other.
- .7  $SFC$  is the certified specific fuel consumption, measured in g/kWh, of the engines. The subscripts  $ME(i)$  and  $AE(i)$  refer to the main and auxiliary engine(s), respectively. For engines certified to the E2 or E3 duty cycles of the NO<sub>x</sub> Technical Code 2008, the engine Specific Fuel Consumption ( $SFC_{ME(i)}$ ) is that recorded in the test report included in a NO<sub>x</sub> technical file for the engine(s) at 75% of MCR power of its torque rating. For engines certified to the D2 or C1 duty cycles of the NO<sub>x</sub> Technical Code 2008, the engine Specific Fuel Consumption ( $SFC_{AE(i)}$ ) is that recorded on the test report included in a NO<sub>x</sub> technical file at the engine(s) 50% of MCR power or torque rating.

The SFC should 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.

For ships where the  $P_{AE}$  value calculated by paragraphs 2.5.6.1 and 2.5.6.2 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<sub>x</sub> technical file for the engine(s) at 75% of MCR power of its torque rating.

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

For those engines which do not have a test report included in a NO<sub>x</sub> technical file because its power is below 130 kW, the  $SFC$  specified by the manufacturer and endorsed by a competent authority should be used.

At the design stage, in case of unavailability of test report in the NO<sub>x</sub> file, the  $SFC$  specified by the manufacturer and endorsed by a competent authority should be used.

[For LNG driven engines of which SFC is measured in kJ/kWh should be corrected to the SFC value of g/kWh using the standard lower calorific value of the LNG (48,000 kJ/kg), referring to the 2006 IPCC Guidelines.]

- .8  $f_j$  is a correction factor to account for ship specific design elements.
- .1 The power correction factor,  $f_j$ , for ice-classed ships should be taken as the greater value of  $f_{j0}$  and  $f_{j,min}$  as tabulated in Table 1 but not greater than  $f_{j,max} = 1.0$ .

For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7<sup>4</sup>.

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<sup>3</sup> **Note:** The electric power table should be examined and validated by the Administration. 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 should apply.

<sup>4</sup> HELCOM Recommendation 25/7 may be found at <http://www.helcom.fi>.

**Table 1:** Correction factor for power  $f_j$  for ice-classed ships

Ship Type	$f_{j0}$	$f_{j,min}$ Depending on Ice Class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.516L_{PP}^{1.87}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.72L_{PP}^{0.06}$	$0.61L_{PP}^{0.08}$	$0.50L_{PP}^{0.10}$	$0.40L_{PP}^{0.12}$
Bulk Carrier	$\frac{2.150L_{PP}^{1.58}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.89L_{PP}^{0.02}$	$0.78L_{PP}^{0.04}$	$0.68L_{PP}^{0.06}$	$0.58L_{PP}^{0.08}$
General Cargo Ship	$\frac{0.045L_{PP}^{2.37}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.85L_{PP}^{0.03}$	$0.70L_{PP}^{0.06}$	$0.54L_{PP}^{0.10}$	$0.39L_{PP}^{0.15}$

- .2 The factor  $f_j$  for shuttle tankers with propulsion redundancy should be  $f_j = 0.77$ . This correction factors applies to shuttle tankers with propulsion redundancy between 80,000 and 160,000 deadweight. The Shuttle Tankers with Propulsion Redundancy are tankers used for loading of crude oil from offshore installations equipped with dual-engine and twin-propellers need to meet the requirements for dynamic positioning and redundancy propulsion class notation.
- .3 For other ship types,  $f_j$  should be taken as 1.0.
- .9  $f_w$  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), and should be determined as follows:
- .1  $f_w$  should be taken as one (1.0) until the Guidelines for the ship-specific simulation (paragraph 2.9.1) or  $f_w$  table/curve (paragraph 2.9.2) becomes available.
- .2 It can be determined by conducting the ship-specific simulation of its performance at representative sea conditions. The simulation methodology should be prescribed in the Guidelines developed by the Organization and the method and outcome for an individual ship should be verified by the Administration or an organization recognized by the Administration.
- .3 In case that the simulation is not conducted,  $f_w$  value should be taken from the "Standard  $f_w$ " table/curve. A "Standard  $f_w$ " table/curve, which is to be contained in the Guidelines, is given by ship type (the same ship as the "reference line" below), and expressed in a function of the parameter of *Capacity* (e.g., DWT). The "Standard  $f_w$ " table/curve is to be determined by conservative approach, i.e. based on data of actual speed reduction of as many existing ships as possible under representative sea conditions.

Comment of CG coordinator 3 :  $f_w$

China commented that "According to discussions on  $f_w$  matter at previous meetings and Japanese paper MEPC 61/5/34 regarding the application of  $f_w$  for required EEDI calculation and voluntary use, the section should be addressed to reflect this point."

On the other hand, Germany commented " $f_w$  should be handled separately according to Japanese proposal in MEPC 61/5/34."

CG Coordinator understand that proposal on  $f_w$  from Japan (MEPC 61/5/34) did not reach agreement at WG established during MEPC 61, and it was agreed to reconsider it at MEPC 62 based on the entire draft of fw simulation guidelines submitted by Japan.

- .10  $f_{eff(i)}$  is the availability factor of each innovative energy efficiency technology.  $f_{eff(i)}$  for waste energy recovery system should be one (1.0)<sup>5</sup>.
- .11  $f_i$  is the capacity factor for any technical/regulatory limitation on capacity, and can be assumed one (1.0) if no necessity of the factor is granted.
- .1 The capacity correction factor,  $f_i$  for ice-classed ships should be taken as the lesser value of  $f_{i0}$  and  $f_{i,max}$  as tabulated in Table 2, but not less than  $f_{i,min} = 1.0$ . For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7<sup>6</sup>.

**Table 2:** Capacity correction factor  $f_i$  for ice-classed ships

Ship Type	$f_{i0}$	$f_{i,max}$ Depending on Ice Class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.00115L_{PP}^{3.36}}{Capacity}$	$1.31L_{PP}^{-0.05}$	$1.54L_{PP}^{-0.07}$	$1.80L_{PP}^{-0.09}$	$2.10L_{PP}^{-0.11}$
Bulk Carrier	$\frac{0.000665L_{PP}^{3.44}}{Capacity}$	$1.31L_{PP}^{-0.05}$	$1.54L_{PP}^{-0.07}$	$1.80L_{PP}^{-0.09}$	$2.10L_{PP}^{-0.11}$
General Cargo Ship	$\frac{0.000676L_{PP}^{3.44}}{Capacity}$	1.0	1.08	1.12	1.25
Container Ship	$\frac{0.1137L_{PP}^{2.29}}{Capacity}$	1.0	$1.25L_{PP}^{-0.04}$	$1.60L_{PP}^{-0.08}$	$2.10L_{PP}^{-0.12}$
Gas Tanker	$\frac{0.1749L_{PP}^{2.33}}{Capacity}$	$1.25L_{PP}^{-0.04}$	$1.60L_{PP}^{-0.08}$	$2.10L_{PP}^{-0.12}$	1.0

<sup>5</sup> EEDI calculation should be based on the normal sea-going condition outside Emission Control Area designated under paragraph 6 of a regulation 13 in MARPOL ANNEX VI.

<sup>6</sup> HELCOM Recommendation 25/7 may be found at <http://www.helcom.fi>.

- .2  $f_i$  for ship specific voluntary structural enhancements is equal to the ratio: (DWT before enhancements)/(DWT after enhancements). This correction factor should be taken as 1.0 until guidelines are developed<sup>7</sup>.
- .1 DWT before enhancements, is the deadweight prior to application of the structural enhancements. DWT after enhancements, is the deadweight resulting following the application of the verified extra steel weight of the structural enhancements.
  - .2 In case DWT before enhancements is not readily available; it can be calculated by adding the steel weight of applicable structural enhancements to the DWT after enhancements.
  - .3 Only the additional steel weight of structural enhancements, applied over and above the standard applicable regulations for the ship type and intended trade, is to be accounted for in " $f_i$  for ship specific voluntary structural enhancements". Examples include increased longitudinal strength, increased structural class notations, increased bow slamming reinforcement, etc.
- .3 For other ship types,  $f_i$  should be taken as 1.0.
- .12 *Length between perpendiculars,  $L_{pp}$*  means 96 per cent of the total length on a waterline at 85 per cent 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. In ships designed with a rake of keel the waterline on which this length is measured should be parallel to the designed waterline. The length between perpendiculars ( $L_{pp}$ ) should be measured in metres.

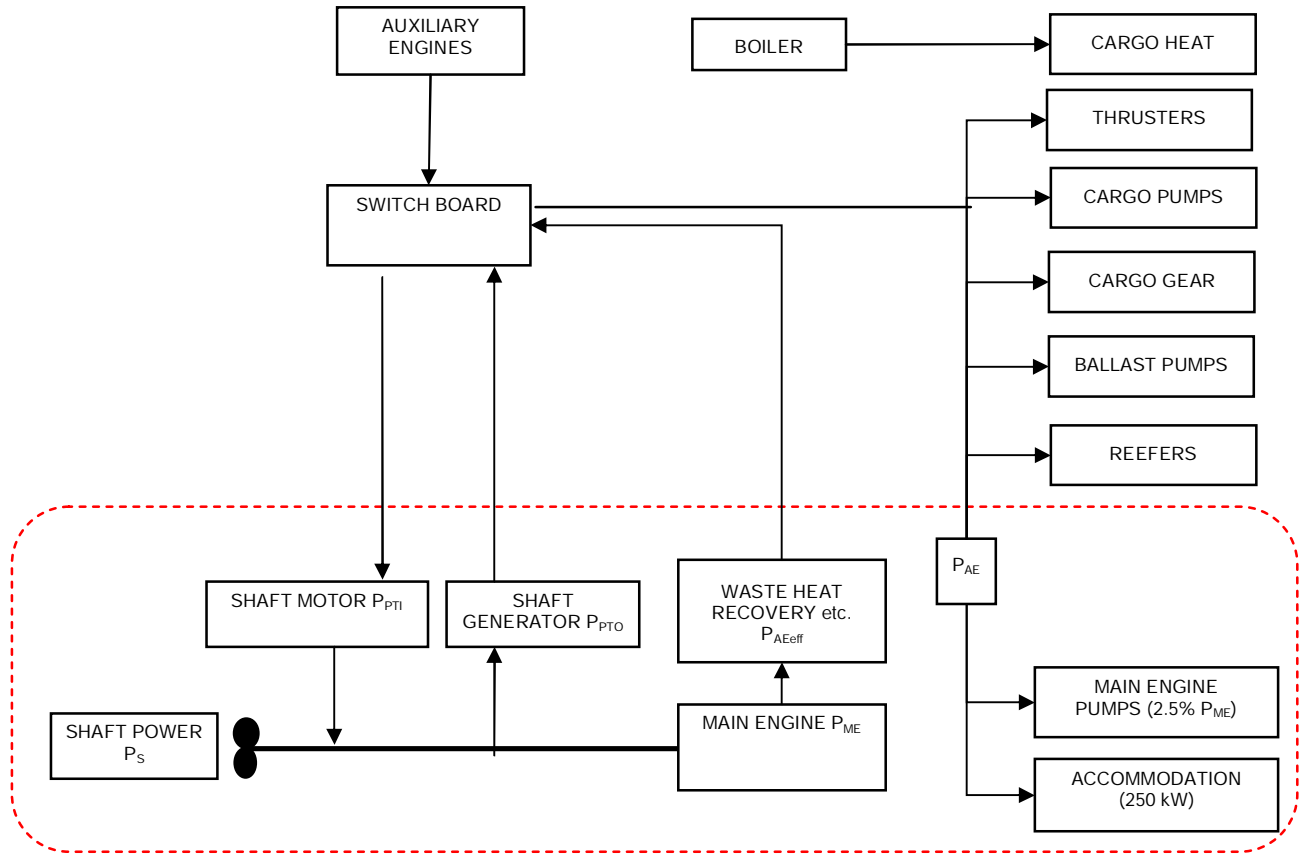
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<sup>7</sup> Guidelines to be developed.

APPENDIX 1

A GENERIC AND SIMPLIFIED MARINE POWER PLANT



**Note 1:** Mechanical recovered waste energy directly coupled to shafts need not be measured, since the effect of the technology is directly reflected in the  $V_{ref}$ .

**Note 2:** In case of combined PTI/PTO, the normal operational mode at sea will determine which of these to be used in the calculation.

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## APPENDIX 2

### GUIDELINES FOR THE DEVELOPMENT OF ELECTRIC POWER TABLES FOR EEDI (EPT-EEDI)

#### 1 Introduction to the document "Electric Power Table for EEDI"

1.1 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

2.2  $P_{AE}$  is to be calculated as indicated in paragraph 2.5.6 of MEPC.1/Circ.681, 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 passenger and/or cargo 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 should 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

### Load groups

4.1 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 Laundries 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 *PA<sub>eff</sub>*, 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 rows 4 and 5 of paragraph 2.5.6 of MEPC.1/Circ.681, 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 row 5 of paragraph 2.5.6 of MEPC.1/Circ.681;
- .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(j)*) and the auxiliaries which are part of them (shaft motor own cooling fans and pump, 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 equipments 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 ( $kl=1$ ,  $kt=1$  and  $kd=1$ ) 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,  $kd$  is to represent the use of spare chillers (e.g., four chillers are installed and one out four is spare then  $kd=0$  for the spare chiller and  $kd=1$  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 Laundries 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 equipments, 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 should be grouped into sub-groups aimed to identify possible improvements of efficient use of power. The sub-groups 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., typical cabins).

#### 4.1.10 L – Entertainment services

This group includes all Loads related to the entertainment services that typically are: public spaces audio and video equipments, theatre stage equipments, 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.

### ***Loads description***

4.2 This identifies the loads (for example "sea water pump").

### ***Loads identification tag***

4.3 This tag identifies the loads according to the shipyard's standards tagging system. For example, the "PTI1 fresh water pump" identification tag is "SYYIA/C" for an example ship and shipyard. This data provides a unique identifier for each load.

### ***Loads electric circuit Identification***

4.4 This is the tag of the electric circuit supplying the load. Such information allows the data validation process.

**Loads mechanical rated power " $P_m$ "**

4.5 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.

**Loads electric motor rated output power [kW]**

4.6 The output power of the electric motor as per maker's name plate or technical specification. This data does not take part of the calculation but is useful to highlight potential over rating of the combination motor-mechanical load.

**Loads electric motor efficiency " $e$ " [/]**

4.7 This data is to be entered in the document only when the electric load is made by an electric motor driving a mechanical load.

**Loads rated electric power " $P_r$ " [kW]**

4.8 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 name plate and/or 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].

**Service factor of load " $k_l$ " [/]**

4.9 Provides the reduction from the loads rated electric power to loads necessary electric power that is to be made when the load absorb 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  $k_l$ .

**Service factor of duty " $k_d$ " [/]**

4.10 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/stand-by their  $K_d$  factor will be  $\frac{1}{2}$  and  $\frac{1}{2}$ . When three compressors serves the same circuit and one runs in duty and two in stand-by, then  $k_d$  is  $\frac{1}{3}$ ,  $\frac{1}{3}$  and  $\frac{1}{3}$ .

**Service factor of time " $k_t$ " [/]**

4.11 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  $k_t = 1$ .

### **Service total factor of use "ku" [/]**

4.12 The total factor of use that takes into consideration all the service factors:  
 $ku=kl \cdot kd \cdot kt$ .

### **Loads necessary power "Pload" [kW]**

4.13 The individual user contribution to the auxiliary load power is  $Pload=Pr \cdot ku$ .

### **Notes**

4.14 A note, as free text, could be included in the document to provide explanations to the verifier.

### **Groups necessary power [kW]**

4.15 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 *PAE*. However, it is useful to allow a quantitative analysis of the *PAE*, providing a standard breakdown for analysis and potential improvements of energy saving.

### **Auxiliaries load's power PAE [kW]**

4.16 Auxiliaries load's power *PAE* 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.

$$PAE = \sum Pload(i) / (\text{average efficiency of the generator(s) weighted by power})$$

### **Layout and organization of the data indicated in the "Electric power table for EEDI"**

5 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 this guideline;
- .4 one Column for the group descriptions as indicated in paragraphs 4.1.1 to 4.1.12 of this guideline;
- .5 one column each for items in paragraphs 4.2 to 4.14 of this guideline (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 this guideline; and
- .8 explanatory notes.

An example of an Electric Power Table for EEDI for a cruise postal vessel which transports passenger 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 Maximum Sea Load)
id	Load group	Load description	Load identification tag	Load electric circuit identification	Load mechanical power "Pm" [kW]	Load electric motor rated output power [kW]	Load electric motor efficiency "e" [%]	Load Rate electric power "Pr" [kW]	service factor of load "kl" [%]	service factor of duty "kd" [%]	service factor of time "kt" [%]	service total factor of use "ku" [%]	Load necessary power "Pload" [kW]	Note	
1	A	Hull cathodic protection Fwd	xxx	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	xxx	yyy	n.a.	n.a.	n.a.	7.0	1	1	1*	1	7	*in use 24hours/day	
3	A	Hull cathodic protection aft	xxx	yyy	n.a.	n.a.	n.a.	4.8	1	1	1*	1	4.8	*in use 24hours/day	
4	A	Ballast pump 3	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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 control unit	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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 circulation pump	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	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	xxx	yyy	30	40	0.93	32.3	0.5	1	0.175*	0.0875	0.9	*in use 4hours/day	
47	H	vaccum collecting system 4 pump a	xxx	yyy	10	13	0.92	10.9	0.9	1	1*	0.9	8.7	*in use 24hours/day	
48	H	sewage treatment system 1 pump 1	xxx	yyy	15	17	0.93	16.1	0.9	1	1*	0.9	8.7	*in use 24hours/day	
49	H	Gym running machine	xxx	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 lighting 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	xxx	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	xxx	yyy	n.a.	n.a.	n.a.	2.0	1	1	0.3*	0.3	0.6	*in use 7.2hours/day	
55	M	Cor Garage supply fan1	xxx	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 reefer hold n.2	xxx	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	xxx	yyy	30	40	0.93	32.3	0.9	1	0.3*	0.27	0.2	*in use 7.2hours/day	
												<b>ΣPload(i)=</b>	<b>3764</b>		

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)

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