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PREVENTION OF AIR POLLUTION FROM SHIPS

Consideration of the Energy Efficiency Design Index for New Ships

Guideline for the uniform definition of Electric power Table for EEDI

Submitted by Cruise Lines International Association (CLIA)

SUMMARY

Executive summary:	This document proposes guidelines to calculate the Auxiliaries load for passenger ship "P_{AE}"
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.2 and 7.3.1.3
Action to be taken:	Paragraph 34
Related documents:	MEPC 59/4/2, annex 2 and GHG-WG 2/2/21

Introduction

1 The definition of the Auxiliaries load has primary relevance within the EEDI definition for passenger ships. As the auxiliary loads power "P_{AE}" is resulting from the summation of a large number of loads derived from the shipyard's load balance, this document explores the introduction of verifiable and auditable guidelines for the calculation, proposing some basic concepts to be used in the future finalization at IMO.

Objective

2 The objective of this document is to propose uniform guidelines for the auxiliaries load power "P_{AE}" calculation.

Auxiliaries load's power definition

3 P_{AE} has to be provided by the total consumed electric power (excluding electric power used for propulsion) in a condition when the ship is engaged in voyage at the reference speed (*Vref*) with outside ambient temperature 35°C, 85% relative humidity, a sea water temperature of 32°C, full passenger load, calm sea conditions, no emergency situations and an evaluation time frame of 24 hours divided by the weighted average efficiency of the generator(s).

Introduction to the document "Electric Power Table for EEDI"

4 This document proposes guidelines 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 loads' 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 auxiliaries load, allowing comparisons between different ships and technologies and eventually identifying potential efficiency improvements.

Definition of the data to be included in the Electric Power Table for EEDI

5 The Electric power table for EEDI calculation must contain the following data elements:

• Load's group	• Service factor of load *"kl"* [/]
• Load's description	• Service factor of duty *"kd"* [/]
• Load's identification tag	• Service factor of time *"kt"* [/]
• Load's electric circuit Identification	• Service total factor of use *"ku"* [/], where *ku=kl·kd·kt*
• Load's mechanical rated power "*Pm*" [*kW*]	• Load's necessary power *"Pload"* [*kW*], where *Pload=Pr·ku*
• Load's electric motor rated output power [*kW*]	• Notes
• Load's electric motor efficiency "*e*" [/]	• Group's necessary power [*kW*]
• Load's Rated electric power *"Pr"* [*kW*]	• Auxiliaries load's power P_{AE} [*kW*]

Load's group

6 In general, all the ship's loads have to be delineated in the document, excluding only the propulsion chain and propulsion motors (while the propulsion services auxiliaries are partially included below in paragraph 8). This makes it easier to verify that all the loads have been considered in the document and there are no loads left out of the measurement. 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:

• A – Hull, Deck, Navigation and Safety services	• F – Air Conditioning services
• B – Propulsion services auxiliaries	• G – Galleys, refrigeration and Laundries services
• C – Auxiliary Engine and Main Engine Services	• H – Accommodation services
• D – Ship's General services	• I – Lighting and socket services
• E – Ventilation for Engine rooms and Auxiliaries room	• L – Entertainment services
	• M – Miscellaneous

Hull, Deck, Navigation and safety services

7 Loads included in the Hull services typically are: ICCP systems, mooring equipment, various doors, ballasting systems, bilge systems, stabilising equipment, etc.:

.1 Loads included in the deck services typically are: deck and balcony washing systems, rescue systems, cranes, etc.;

.2 Loads included in the navigation services typically are: navigation systems, navigation's external and internal communication systems, steering systems, etc.; and

.3 Loads included in the safety services typically are: active and passive fire systems, emergency shut down systems, public address systems, etc.

Propulsion services auxiliaries

8 Typically, the Loads included in this group are: propulsion secondary cooling systems such as shaft motor dedicated LT cooling pumps, converters dedicated to LT cooling pumps, propulsion UPSs, etc. Propulsion services Load **does not include** the shaft motors ($P_{TI(i)}$) with the auxiliaries that are part of them (shaft motors' fan and pump, etc.) and the shaft motors' chain losses with their auxiliaries that are part of them (i.e. shaft motors' converter including relevant auxiliaries losses , shaft motors' transformer including relevant auxiliaries losses, shaft motors' harmonic filter including relevant auxiliaries losses, shaft motors' excitation system including the relevant auxiliaries consumed power, etc.). Propulsion services auxiliaries include manoeuvring propulsion equipments such as thrusters and their auxiliaries. To be noted; **their contribution to the final figure is likely to be zero** as their global use factor is likely to be minimal (normally the manoeuvring thrusters are off at the normal sea going conditions). However, their inclusion in the document is still important for the verification process.

Auxiliary Engine and Main Engine Services

9 Loads typically included in this group are: cooling systems i.e. pumps and fans for cooling circuits dedicated to generators 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.

Ship's General services

10 This group includes those Loads that 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.

Ventilation for Engine rooms and Auxiliaries room and Garages

11 This group includes all fans providing ventilation for engine rooms and auxiliary's rooms that typically are: engine rooms cooling supply-exhaust fans, auxiliaries' rooms supply and exhaust fans, garage supply and exhaust fans, etc. All the fans serving the accommodation areas or supplying combustion air are not included in this group.

Air Conditioning services

12 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 a.h.u. 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 verification of the heat load dissipation document (i.e. the chiller's electric motor rated power is to be used). However, *kd* can represent the use of spare chillers but only when the number of spare chillers is clearly demonstrated via a heat load dissipation document (avoiding penalization of the spare power).

Galleys, refrigeration and Laundries services

13 All Loads related to the galleys, pantries refrigeration and laundry services that typically are: various galley machines, cooking appliances, galleys' cleaning machines, galleys auxiliaries, refrigerated room systems including refrigeration compressors with auxiliaries, air coolers, etc.

Accommodation services

14 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.

Lighting and socket services

15 All Loads related to the lighting, entertainment and socket services. As the quantity of lighting circuits and sockets within the ship is significantly high, it is not practically feasible to list all the lighting circuits within the document. As a consequence the circuits must be grouped into sub-groups aimed to identify possible improvements of efficient use of power. The sub-groups are:

.1 Lighting of cabins, corridors, technical rooms/stairs, public spaces/stairs, engine-rooms and auxiliaries' room, external areas. All have to be divided by main vertical zone; and

.2 Sockets of cabins, corridors, technical rooms/stairs, public spaces/stairs, engine rooms and auxiliaries' room. All have to be divided by main vertical zone.

The calculation criteria of the cabin subgroups are to be included via an explanatory note, indicating the load composition (lights of the typical cabin, TV, hair dryer, fridge, etc.).

Entertainment services

16 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.

Miscellaneous

17 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 sea load.

Loads description

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

Loads identification tag

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

Loads electric circuit Identification

20 This is the tag of the electric circuit supplying the load. Such information can allow a data validation process, if needed.

Loads mechanical rated power "Pm"

21 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, pump, etc.). This is the rated power of the mechanical device driven by an electric motor.

Loads electric motor rated output power (kW)

22 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 over rating of the combination motor-mechanical load.

***Loads electric motor efficiency "e"* (/)**

23 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 "Pr" (kW)

24 Typically the maximum electric power absorbed at the load's 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: *Pr=Pm/e (kW).*

Service factor of load "kl" (/)

25 Provides the reduction from the load's 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 an electric motor driving a mechanical load, a fan could be designed with some margin, leading to the fact that the fan's 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 to a factor *kl.*

***Service factor of duty "kd"* (/)**

26 Factor of duty is to be used when a function is provided by more than one load. As all the loads have to be included in the document, 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 *Kd* factor will be 1/2 and 1/2. When three compressors serves the same circuit and one runs in duty and two in stand-by, then *kd* is 1/3, 1/3 and 1/3.

***Service factor of time "kt"* (/)**

27 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 of 24 hours; as a consequence *kt=4/24.* For example, the sea water cooling pumps operate at their power all the time during navigation at *Vref.* As a consequence *kt=1*.

***Service total factor of use "ku"* (/)**

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

Load's necessary power "Pload" (kW)

29 The user's contribution to the auxiliaries load's power P_{AE}. $Pload=Pr \cdot ku$.

Notes

30 A note, as free text, can be included in the document to provided explanations, etc.

Groups necessary power (kW)

31 The summation of the "Load's necessary power" from group A to M. This is an intermediate step which is not necessary to the calculation of P_{AE}. However, it is useful to allow a quantitative analysis of the P_{AE}, providing a standard breakdown.

Auxiliaries load's power P_{AE} (kW)

32 Auxiliaries load's power P_{AE} is the summation of the "Load's necessary power" of all the loads. $P_{AE} = \Sigma Pload(i)$

Layout and organization of the data indicated in the Electric power table for EEDI.

33 The electric power table includes general information (i.e. ship's name, project name, document references, etc.) and a table with:

- One row containing columns' titles;
- One Column each for the data 6A to 6M;
- One row dedicated to every single load;
- The summation results (totals of powers) including the data 31 and 32; and
- Explanatory notes.

An example of an electric power table for calculation of EEDI is attached as annex (in English only). The data indicated is for reference only.

Action requested of the Committee

34 The Committee is invited to consider the above proposed guidelines and take action as appropriate.

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ANNEX

ELECTRIC POWER TABLE FOR CALCULATION OF EEDI

ELECTRIC POWER TABLE FOR EEDI HULL "EXAMPLE" PROJECT "EXAMPLE"

id	Load's group	Load's description	Load's identification tag	Load's electric circuit Identification	Load's mechanical rated power "*Pm*" [*kW*]	Load's electric motor rated output power [*kW*]	Load's electric motor efficiency "*e*" [*/*]	Load's Rated 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's 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	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 **N**ormal **S**ea **L**oad condition (i.e."**NSL**")
5	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
6	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
7	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
8	A	Stabilisers control unit	xxx	yyy	n.a.	n.a.	n.a.	0.7	1	1	1*	1	0.7	*in use 24hours/day
9	A	Stabilisers Hydraulic pack power pump 1	xxx	yyy	80	90	0.9	88.9	0.9	1	0*	0	0	*NSL=> calm sea,=> stabiliser not in use
10	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
11	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
12	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
13	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
14	A	High pressure water fog contol unit	xxx	yyy	n.a.	n.a.	n.a.	1.2	1	1	1*	1	1.2	*in use 24hours/day
15	A	High pressure water fog engines rooms pump 1a	xxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0	0	*NSL=> not emergency =>Load not in use
16	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
17	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
18	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
19	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)
20	B	Bow thruster 1	xxx	yyy	3000	3000	0.96	3125.0	1	1	0*	0	0	*NSL=>thrusters motor are not in use
21	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
22	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
23	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
24	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
25	C	DG3 exhaust gas boiler circulationg pump	xxx	yyy	6	8	0.93	6.5	0.8	1	1*	0.8	5.2	*in use 24hours/day
26	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
27	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
28	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
29	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
30	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
31	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
32	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
33	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
34	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
35	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 document
36	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 document
37	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 document
38	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
39	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
40	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
41	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
42	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
43	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
44	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
45	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
46	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
47	H	sewage treatmet system 1 pump 1	xxx	yyy	15	17	0.93	16.1	0.9	1	1*	0.9	8.7	*in use 24hours/day
48	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
49	I	Cabin's lighting MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	80*	1	1	1	1	80.0	* see explainatory note
50	I	corridors ligthing MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	10*	1	1	1	1	10.0	* see explainatory note
51	I	Cabin's sockets MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	5*	1	1	1	1	5.0	* see explainatory note
52	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
53	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
54	M	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

***P AE* =3764 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=0.22kW)