Compatibility checks according to the IEC 80005-1

POWERCON
PORT OF OSLO

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Contents

1 Revision History ... 3

2 Document Purpose ... 3

3 Persons in Charge ... 3

3.1 From Ship ... 3

3.2 From Shore ... 4

4 Ship Information ... 4

5 Compatibility assessment procedure ... 4

5.1 Compliance (a) ... 4

5.2 Short-circuit current (b)(C) ... 4

5.3 Inrush current (q) ... 5

5.4 Nominal voltage ratings ... 5

5.4.1 Nominal voltage (i) ... 5

5.4.2 Frequency ... 5

5.4.3 Power requirements ... 5

5.4.4 Phase sequence ... 5

5.4.5 Transfer speed (s) ... 5

5.5 Voltage variations (e) (f) ... 6

5.5.1 Continuous voltage and frequency tolerances ... 6

5.5.2 Transient voltage and frequency tolerances ... 6

5.6 Equipment impulse withstand voltage (h) ... 6

5.7 Harmonic characteristics (o) ... 6

5.8 Communication and control voltages (j) ... 7

5.8.1 24V control signals (n) ... 8

5.8.2 110V control signals (n) ... 8

5.9 Earthing ... 8

5.9.1 Ship earth fault (l) ... 8

5.9.2 Transformer neutral earthing (k) ... 9

5.10 Cable management ... 9

5.10.1 Mooring plan and hatch placement ... 9

5.10.2 Cable tension monitoring ... 9

5.11 Galvanic isolation (r) ... 9

5.12 Bonding monitoring (t) ... 10

5.13 Location and construction ... 10

5.13.1 hazardous areas (p) 10
6 Appendix A – Considerations for further calculations (as per IEC 800005-1 section 4.8)........ 11
6.1 a) Electrical load 11
6.2 b) Short circuit contribution considerations 11
6.3 c) System configuration 11
6.4 d) System charging 11
6.5 e) NER system 11
6.6 f) Transient overvoltage protection 11
6.7 g) Fail-safe principle for cables/connectors operation........ 11
7 Appendix B Supporting documents. 12
7.1 Single line diagram .... **Feil! Bokmerke er ikke definert.**
7.2 Relay settings........ **Feil! Bokmerke er ikke definert.**

1 Revision History

Date	Rev.	Changes	Author	Reviewed by
13-02-2024	1.0	Initial Version – new base	AHJ	

2 Document Purpose

A step-by-step procedure for a compatibility assessment to verify compatibility between ship and the High Voltage Shore Connection (HVSC) system, according to IEC 80005-1 section 4.3.

This assessment is only needed the very first time before a ship connects to the HVSC system or if the ship or HVSC has changed. If there has been changes on shore or ship side each part must notify the other part to ensure that the changes are evaluated and tested.

In the sections (x) refers to the naming following section 4.3 of IEC/IEEE 80005-1

3 Persons in Charge

In this section the persons in charge from both ship and shore signs that the below procedure is followed, and all relevant boxes are checked. If a step is excluded a comment must be made next to the line or in section 5.1.

3.1 From Ship

- Name: ______________________
- Company: ______________________
- Date: ______________________

- Signature: ______________________________

3.2 From Shore

- Name: ______________________________
- Company: ______________________________
- Date: ______________________________
- Signature: ______________________________

4 Ship Information

- Date: ______________________________
- Ship's name: ______________________________
- Ship's IMO number: ______________________________

5 Compatibility assessment procedure

5.1 Compliance (a)

Are the HVSC and the ship in compliance with IEC 80005-1 and what deviations from its recommendations might there be:

☒ HVSC in compliance

☐ Ship in compliance

Deviations from IEC 80005-1 and recommendations:

____

____

____

____

____

____

5.2 Short-circuit current (b)(C)

What is the minimum and maximum prospective short-circuit current calculations (see IEC 61363-1) for the HVSC and ship installations:

HVSC prospective short-circuit current: Max 1500 A Min 1300 A

Ship prospective short-circuit current: Max ________ A Min ________ A

System prospective short-circuit current limits shall be within 25 kA RMS.

5.3 Inrush current (q)

Do the ship have means to prevent large loads from starting if they would trigger a failure and/or do the system reduce inrush current:

☐ Inrush limiting ☐ Start prevention

What are the ship limits of the inrush and/or start prevention:

Max inrush current: ______________A

Max start prevention current: ______________A

Note: If the component that generates the largest inrush can be identified this can be tested during first call.

5.4 Nominal voltage ratings

5.4.1 Nominal voltage (i)

HVSC nominal voltage: ☒ 6,6 kV ☒ 11 kV

Ship nominal voltage: ☐ 6,6 kV ☐ 11 kV

Nominal voltage output from the HVSC system can be changed to match the ship.

5.4.2 Frequency

HVSC operating frequency: ☒ 60 Hz ☒ 50 Hz

Ship operating frequency: ☐ 60 Hz ☐ 50 Hz

Frequency of the HVSC system can be changed to match the ship.

5.4.3 Power requirements

HVSC maxium power: 16MVA

Ship expected power: _____MVA

Does the ship match the available power level?

☐ Yes ☐ No

5.4.4 Phase sequence

HVSC phase sequence: ☒ counter-clockwise (L1-L2-L3) ☐ clockwise (L1-L3-L2)

Ship phase sequence: ☐ counter-clockwise (L1-L2-L3) ☐ clockwise (L1-L3-L2)

5.4.5 Transfer speed (s)

Ship desired transfer rate: ______________MW/min

5.5 Voltage variations (e) (f)

Is the HVSC system and ship voltage and frequency variations within the standard limits. There are two sets of limits: continuous and transient. All values shall be measured or based on data from the connection point.

5.5.1 Continuous voltage and frequency tolerances

The HVSC uses continuous regulation to maintain a steady state voltage and maintain a stable frequency.

5.5.2 Transient voltage and frequency tolerances

Based upon the maximum load change for the ship, the voltage change at HVSC system output is calculated from a sum of converter line output impedances. Cable and busbars are neglected because it has little to no effect on the final impedance compared to the contribution of the boost reactor and the transformer.

The HVSC system impedance is calculated based on the values from the short-circuit model for the system.

Impedance of system is 1,41Ohms

Multiply the impedance with the reactive voltage step to find the voltage change.

Based upon the above calculations and the ships maximum step loads, the HVSC system:

☐ Transient voltage increase is below +20% of nominal voltage

☐ Transient voltage decrease is above -15% of nominal voltage

☐ Transient frequency variation is less than ±10% of operating frequency

Note: The HVSC uses continuous regulation to monitor and maintain a stable frequency.

The part of the system subjected to the largest voltage dip or peak in the event of the maximum step load being connected or disconnected are:

____

____

____

____

5.6 Equipment impulse withstand voltage (h)

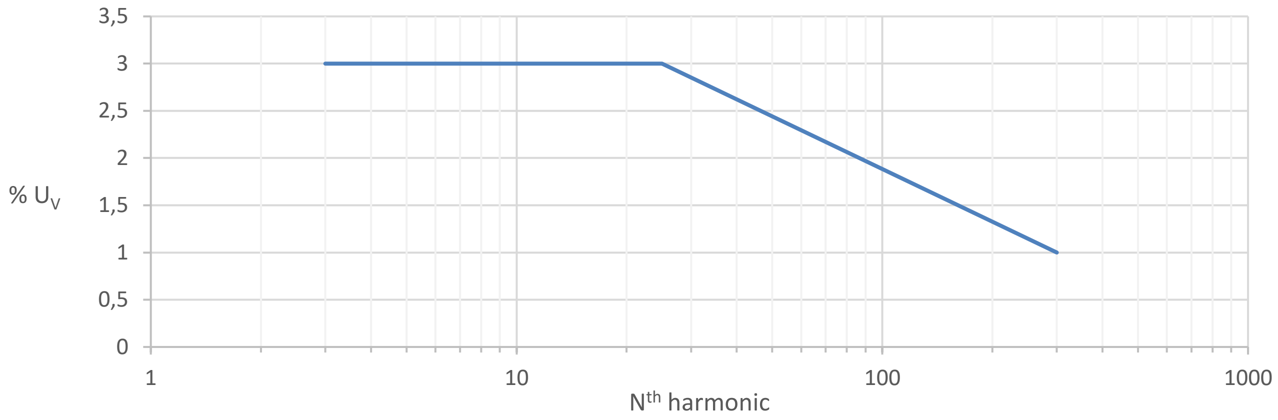
Ship equipment impulse withstand voltage: __________ kV

HVSC system equipment impulse withstand voltage: 60 kV

5.7 Harmonic characteristics (o)

☒ The Total Harmonic Distortion (THD) limits for the HVSC system voltage at no-load condition are below 3 % single harmonics and 5 % for THD (Total Harmonic Distortion). Above 25^{th} harmonic limits are given in IEC 80005-1 section 5.2 or Figure 5-1.

Figure 5-1 - Single harmonic distortion limits



Any known limitation from ships side om these harmonics:

☐ Yes ☐ No

5.8 Communication and control voltages (j)

Which communication and control voltages are available for:

HVSC: ☒ $110V_{DC}$ ☒ $24V_{DC}$

Ship: ☐ $110V_{DC}$ ☐ $24V_{DC}$

Other means of communication (Like radio or telephone):

5.8.1 24V control signals (n)

Ship:	HVSC:		Pins:
☐	☒	Permission to close 6,6 kV **	1, 2
☐	☒	Ground relay check **	3, 4
☐	☐	Capacitor bank alarm*	5, 6
☐	☐	Capacitor bank – Stage 2 indication *	7, 8
☐	☒	Transformer temp. – Stage 1 alarm *	9, 10
☐	☒	Transformer temp. – Stage 2 alarm *	11, 12
☐	☐	Permission to start capacitor sequence *	13, 18
☐	☐	Capacitor bank – Stage 1 indication *	14, 15
☐	☒	Permission to close 11 kV **	16, 17
☐	☐	Capacitor circuit breaker position *	19, 20
☐	☐	Capacitor bank – Stage 3 indication *	21, 22
☐	☐	Ground monitoring relay *	23, 24

* Optional
** Part of safety circuit

Note: *All capacitor related control signals are not available from HVSC system.*

5.8.2 110V control signals (n)

Ship:	HVSC:		Pins:
☐	☒	Permission to close 6,6 kV **	1, 2
☐	☒	Emergency stop **	3, 4
☐	☒	Circuit breaker trip 6,6 kV **	5, 6
☐	☒	Shore ground indication	7, 8
☐	☒	Frequency setting	9, 10
☐	☒	Reduce power warning	11, 12
☐	☒	Expected shutdown warning	11, 13
☐	☒	Circuit breaker trip 11 kV **	14, 15
☐	☒	Permission to close 11 kV **	16, 17

** Part of safety circuit

Is the ship and HVSC system safety circuits compatible:

☐ Yes ☐ No

The HVSC system failsafe uses a safety PLC (Programmable Logic Controller) to manage and control all safety related input and outputs. All safety relate I/O's functions are tested and verified.

5.9 Earthing

☒ Ship must connect HVSC earth to ships earth system

5.9.1 Ship earth fault (I)

Ship earth fault setting at HVSC operation condition:

HVSC operation: ________________A

5.9.2 Transformer neutral earthing (k)

☒ The HVSC systems have a neutral earthing resistor with a value of 540 Ω

☒ In the event of an earth fault the power system between shore and ship will not experience a step voltage more than 30 V. (HVSC resistance less than 1 Ω, earth current less than 25A)

5.10 Cable management

5.10.1 Mooring plan and hatch placement

Check with ships mooring plan that the shore power CMS is within the operational space of shore side cable management system.

Height of the shore power hatch compared to sea-level.

Max load: ____________m Min load: ____________m

The cable length needed from shore to ship should include the maximum moveable range of the ship from the quay side and cable inside ship:

Max: ________________m Min: ________________m

Are there sufficient cable (m)?

☐ Yes ☐ No

Are the power cables coiled up during operation:

☒ Yes ☐ No

Any derating from cable coiling (d):

☐ Yes ☒ No ☐ N/A

State if there are special measure with regards to cable length or cable derating:

____

____

____

5.10.2 Cable tension monitoring

Ship and shore measures cable tension limit:

☐ Ship monitors cable tension
☒ Shore monitors cable tension (warning and trip)

5.11 Galvanic isolation (r)

☒ HVSC transformers ensures galvanic isolation between each connected ship.

☐ Ship has a galvanic isolation transformer.

5.12 Bonding monitoring (t)

The HVSC system has continuous monitoring of the bonding as part of the safety system, as required for cruise ships.

5.13 Location and construction

Each container is locked to prevent unauthorised personal from gaining access to the HVSC equipment.

5.13.1 hazardous areas (p)

The HVSC system is permanently installed outside any hazardous area near ship and shore facilities.

☒ HVSC is not placed in a hazardous area.

☐ Ship connection point is placed in a hazardous area.

6 Appendix A – Considerations for further calculations (as per IEC 800005-1 section 4.8)

6.1 a) Electrical load

See section 5.4.3

6.2 b) Short circuit contribution considerations

Shore side contribution is maximum 1500A. This current must be added to generator current when assessing the ships capability.

Shoreside is rated for 25kA in 1s and does not require further calculations to be protected.

6.3 c) System configuration

There are no restrictions from shore side on paralleling. IEC-80005-1 recommends to always limit paralleling to the shortest possible time.

As mentioned in 5.3 the ship must employ inrush limitation or start prevention when using shore power.

6.4 d) System charging

All cables and transformers are charged before they are connected. This means there are no charging of cables. As per D.9.3.1 the system must be either manually or automatically synchronized so no charging occurs at ship cut it.

6.5 e) NER system

Neutral Earthing resistor is designed for 25A for 5s. The resistor is supervised by a littelfuse SE-330 relay. If NER fails system is interrupted.

The current of 25A with a resistance measured to earth of maximum 1 Ohm ensures voltages are below 30V

6.6 f) Transient overvoltage protection

Using the impedance written in 5.5.2 the transient overvoltage can be calculated by multiplying the impedance with the transient reactive current.

Shore side will always move output voltage back to nominal over some seconds so only transient changes should be evaluated. This regulation is not done via tap changer but in a continuous way.

The shore side is equipped with surge arrestors appropriate for a 60kV system being hit by a 10kA lightning.

6.7 g) Fail-safe principle for cables/connectors operation

Shoreside supervision: The safety circuits from the ship is monitored by a fail-safe PLC. Outputs to the ship is driven from the fail-safe PLC using appropriate switching material.

Shipside supervision: Ensure that all safety circuits are meeting the IEC 80005-1 requirements and in particular Annex D

7 Appendix B Supporting documents.