Compatibility Assessment Shore Power

Technical Guide

Cruise OPS, Onshore Power Supply

POWERCON

PROJECT: PLUG BERGEN

Contents

1 Revision History

Date	Rev.	Changes	Author	Reviewed by
22-09-2021	1.0	Initial Version	AHJ	PCK
22-12-2021	1.1	Added required cable length – chapter 5.14	AHJ	PCK
15-06-2022	1.2	Minor updates	AHJ	PCK

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 in Bergen or if the ship or HVSC has changed.

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

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 recommendations:

____
____
____
____
____
____

5.2 Short-circuit current

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 ____2500__ 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

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

5.4 Nominal voltage ratings

5.4.1 Nominal voltage

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 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)

Phase sequence of the HVSC system can be changed to match the ship.

5.5 Voltage variations

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 watch voltage increased and drops and maintain a stable frequency.

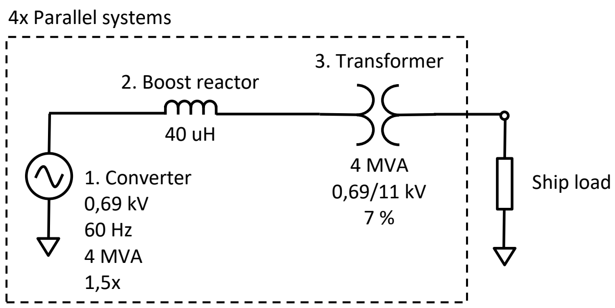
5.5.2 Transient voltage and frequency tolerances

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 spreadsheet. Values are also stated in the figure below.

Impedance primary	
Boost reactor	15,08 mΩ
Transformer	8,33 mΩ
Sum	23,41 mΩ

Impedance scecondary	
$Z_{Secondary}$	5,95 Ω
4 parallel	1,49 Ω

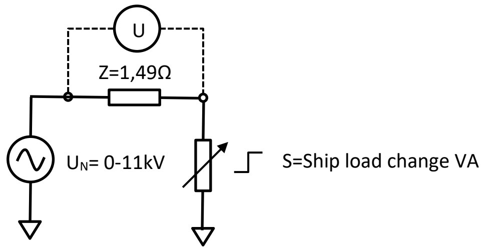


The simplified equivalent diagram seen by the ship consisting of only a variable AC voltage source and an output impedance. The output impedance is the impedance seen on the secondary side of the transformer. The voltage step change across the output impedance is calculated with Equation 1.

Equation 1

$$\boldsymbol{U} = \boldsymbol{I} * \boldsymbol{Z}$$

The voltage should be geometrically added to the base voltage



Ship normal electrical load during connection to a HVSC supply:

Ship normal steady state load - S_N: ____________ MVA

Ship load maximum step change - S: + ____________ MVA

\- ____________ MVA

Calculated HVSC system output voltage increase or decrease during ship maximum load changes:

Nominal voltage - U_N: ____________ V

Voltage increase at ship connection point during load change - U: + ____________ V   Percentage of nominal voltage: ________ 0 %

Voltage decrease at ship connection point during load change - U: - ____________ V   Percentage of nominal voltage: ________ 0 %

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

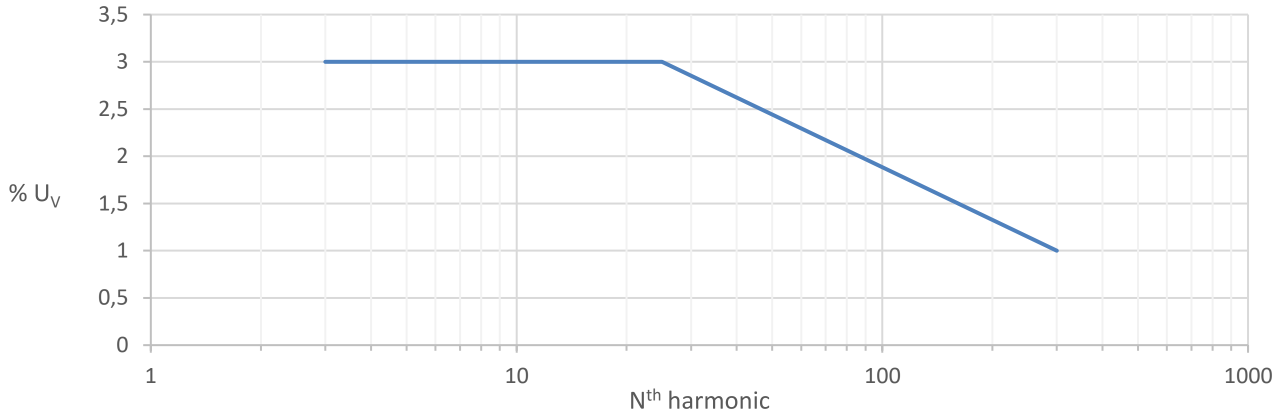
Ship equipment impulse withstand voltage: ____________ kV

HVSC system equipment impulse withstand voltage: ____________ kV

5.7 Harmonic characteristics

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

Figure 5-1 - Single harmonic distortion limits



5.8 Communication and control voltages

Which communication and control voltages are available for:

HVSC: ☒ $110V_{DC}$ ☒ $24V_{DC}$

Ship: ☐ $110V_{DC}$ ☐ $24V_{DC}$

Other means of communication:

____

____

____

Which control signals are supported by the $24V_{DC}$ connector:

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.*

Which control signals are supported by the $110V_{DC}$ connector:

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 to manage and control all safety related input and outputs. All safety relate I/O's functions are tested and verified.

5.9 Earthing

☐ The ship is providing sufficient earthing between ship and shore with a value of ________ Ω

5.9.1 Ship earth fault

If the ship is connected to a HVSC system, is the earth fault setting different from normal settings and are there means to change settings:

☐ Yes ☐ No

Ship earth fault setting at normal and HVSC operation condition:

Normal operation: ____________ A

HVSC operation: ____________ A

5.9.2 Transformer neutral earthing

☒ 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.

5.10 Cable management

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

Max: ________________m Min: ________________m

Are the power cables coiled up during operation:

☐ Yes ☒ No

Any derating from cable coiling:

☐ Yes ☒ No ☐ N/A

Derating from other cable management related aspects:

____

____

____

5.10.1 Cable tension monitoring

Ship and shore maximum cable tension limit:

☐ Ship must provide a cable tension monitoring system.

☐ Shore must provide a cable tension monitoring system.

Ship and/or shore must provide a cable tension monitoring system.

5.11 Galvanic isolation

☐ HVSC transformers ensures galvanic isolation between each connected ship. The isolation also prevents electrochemical corrosion.

☐ Ship has a galvanic isolation transformer

5.12 Bonding monitoring

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

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

5.14 Needed Cable length onboard – from hatch to shipside sockets

- Power cables *Default 3meter*
- Neutral cable *Default 3meter*
- Control cables *Default 3meter*