NEWBUILDINGS
SPECIAL EQUIPMENT AND SYSTEMS – ADDITIONAL CLASS

Electrical Shore Connections

JULY 2014

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TEMPERATURES

The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.

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CHANGES – CURRENT

General
This document supersedes the July 2012 edition.

Text affected by the main changes in this edition is highlighted in red colour. However, if the changes involve a whole chapter, section or sub-section, normally only the title will be in red colour.

Det Norske Veritas AS, company registration number 945 748 931, has on 27th November 2013 changed its name to DNV GL AS. For further information, see www.dnvgl.com. Any reference in this document to “Det Norske Veritas AS” or “DNV” shall therefore also be a reference to “DNV GL AS”.

Main changes July 2014, entering into force 1 January 2015

• Sec.2 Technical requirements
  — In A301, a reference to IEC standard has been added.
  — In A302 and previous A304, requirement to monitoring of earthing connection has been deleted.
  — In B201, B203, B304, B403 and B405, the requirement to automatic disconnection by earth fault has been deleted.
  — In D102, requirement to tripping of circuit breaker in case of failure of protecting earthing connection has been deleted.
  — In D104, requirement to energy measurement (kWh counter) has been deleted.

Editorial corrections

In addition to the above stated main changes, editorial corrections may have been made.
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SECTION 1 GENERAL

A. Introduction

A 100 Objective

101 These rules give requirements to design, installation, and verification of electrical shore connections intended for regular use in harbour for all types of vessels. Typical design intention is vessels following regular routes with frequent visits to the same ports, with port calls lasting sufficiently long to utilise an electrical shore connection.

A 200 Limitations and clarifications

201 Operational features with respect to power availability during loading and unloading are not considered as scope of these rules. The system description shall clarify the vessel’s load balance and the available power from shore for each port where the system shall be used.

202 The availability of the shore power supply depends on the utility systems onshore. However, these rules require that a stand-by generator on-board is automatically started and connected upon loss of power from shore. Additionally, this standard does not require that discriminative protection in the vessel’s electric distribution system is functional while powered by a shore connection. A short circuit in the vessel’s electric distribution system may therefore, in worst case, result in a black-out. Hence, use of shore power supply during loading and unloading operations in port must be evaluated with respect to criticality of electric power supply.

203 These rules do not consider any critical cargo operations, and assumes that the vessel will stay safe in case a power interruption occurs.

A 300 Scope

301 The scope for these rules is to establish requirements to the design of electrical shore connections, the ship side installation of necessary equipment, and to the verification of the installations.

— system functionality
— control systems and control systems interface
— ship side electrical installations
— shore side electrical installations.

The shore side electrical installations are only considered as part of the system design. The physical installation on shore is not covered by these rules. The installation on board the vessel is covered by these rules.

302 The system design comprises the following four aspects:

— system functionality
— control systems and control systems interface
— ship side electrical installations
— shore side electrical installations.

A 400 Application

401 Ships having an electrical shore connection found to satisfy these rule requirements may be assigned the optional class notation Shore Power.

402 While a type approval may be issued for a specific system design and component specification, the optional class notation Shore Power requires that the installation on board the vessel have been verified and tested.
A 500 Relation to other DNV documents

501 Electrical installations is in general described in Pt.4 Ch.8.

502 Control and Monitoring Systems is in general described in Pt.4 Ch.9.

B. Procedural Requirements

B 100 Verification and Certification

101 When the optional class notation Shore Power shall be assigned, the electrical shore connection system and the on-board equipment shall be verified and certified in compliance with these rules.

102 An electrical shore connection is not deemed safe to use unless the compatibility between the vessel and the shore side installation is verified for each port where the connection shall be used. Such verification is an operational matter, and not covered by this class notation. The electrical shore connection system shall be constructed in accordance with plans approved by the Society. The electrical shore connection system shall be documented as described in B200.

103 When the optional class notation Shore Power shall be assigned, electrical equipment installed on-board for the electrical shore connection are regarded as important equipment, and shall be delivered with NV product certificates as described in Pt.4 Ch.8 Sec.1 B300. Control and monitoring system for the electrical shore connection shall also be regarded as important, and be delivered with NV product certificate as described in Pt.4 Ch.9 Sec.1 A202.

104 Documentation required submitted in conjunction with product certification is given in Pt.4 Ch.8 Sec.1 B202.

105 On-board survey shall be performed as part of the verification process as described in B300.

B 200 Documentation requirements

201 Documentation related to system design shall be submitted as required by Table B1. The system documentation listed in Table C1 shall be submitted for approval or information. Additional documentation may be required, depending on the chosen technical solution.

202 For standard designs, the case by case approval may be replaced by the type approval scheme.

203 Electrical equipment required to be delivered with DNV Product Certificate shall be documented as described in Pt.4 Ch.8 Sec.1 B202.

204 For general requirements to documentation, see Pt.0 Ch.3 Sec.1.
For a full definition of the documentation types, see Pt.0 Ch.3 Sec.2.

<table>
<thead>
<tr>
<th>Object</th>
<th>Documentation type</th>
<th>Additional description</th>
<th>For info 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E010 - Overall single line diagram</td>
<td>Including system earthing for the electric shore connection.</td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>E050 - Single line diagrams/ consumer list for switchboards</td>
<td>Electrical documentation of switchboards and switchgear installed as part of the electrical shore connection system and the cubicle in the main switchboard associated with the electrical shore connection. (Including switchboard layout and arrangement drawings, and schematics with information on protection, synchronisation, breaker interlocks, undervoltage trips, remote control circuits as relevant.)</td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>E040 - Electrical consumption balance</td>
<td>Design values for power consumption and available power for operational modes utilising the electrical shore connection. The load balance shall reflect the operational modes stated in the system philosophy.</td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>E220 - Electrical system philosophy</td>
<td>An overall description of the electrical shore connection system and operating philosophy for all relevant operating modes.</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>E200 - Short circuit calculations</td>
<td>The design values for the maximum and minimum short circuit power from the shore side shall be described.</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>E080 - Discrimination analysis</td>
<td>The selectivity on board the vessel while fed from the electric shore connection shall be described.</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>E210 - Harmonic distortion calculations</td>
<td>Voltage tolerances, waveform and harmonic content in the supply voltage, when the electrical shore connection is powered by a frequency converter.</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>E100 - Voltage drop calculations</td>
<td>Upon request and when a motor rated above 30% rated power of the electrical shore connection is started direct on line.</td>
<td>FI, R</td>
<td></td>
</tr>
<tr>
<td>Z030 - Arrangement plan</td>
<td>Including locations of onboard equipment and main cable routing for the electrical shore connection system</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>I020 - Control system functional description</td>
<td>Functional description including description of instrumentation, interlocks, monitoring and alarms.</td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>Z160 - Operational manual</td>
<td>A document intended for regular use on board, providing information on: operation modes, operating instructions, procedures, and details of the user interface.</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td>Z140 - Test procedure for quay and sea trial</td>
<td></td>
<td>AP</td>
<td></td>
</tr>
</tbody>
</table>

Note 1): For approval (AP) or
For information (FI)
On request (R)

**B 300 Survey and testing requirements**

301 When the optional class notation **Shore Power** shall be assigned, the on-board installation and equipment shall be verified as described in Sec.2 F.

302 Tests additional to the ones described in the approved test program may be required in order to ensure the safety of the installation, deemed on the actual installation.
SECTION 2 TECHNICAL REQUIREMENTS

A. General

A 100 Stand-by power

101 While the electric shore connection is supplying power to the vessel, at least one of the vessel’s generators shall be in standby. I.e. this generator shall be automatically started and connected to the main switchboards in case of blackout (loss of power supply from shore).

102 In order to transfer power between the vessel’s supply and shore, means for synchronization shall be arranged in the vessel’s main switchboard.

A 200 Voltage and frequency

201 When a vessel is powered by shore power supply, the system voltage and frequency of the shore utility supply must match the system voltage and frequency of the vessel.

Guidance note:
A system design where parts of the vessel’s consumers are powered by a shore connection with a different frequency than the nominal frequency of the vessel is acceptable (e.g. reefer load powered by 50 HZ shore power on a 60 Hz vessel). Also a system design with two electrical shore power connections, one with 50 Hz, and one with 60 Hz, is acceptable.

---end---of---Guidance---note---

A 300 System earthing and protective earthing

301 The vessel’s designed system earthing is to be maintained in electrical shore connection operation. The selected design solution must be described in the documentation of the system.

Guidance note:
IEC Publication 80005-1 Utility connections in Port - Part 1: High Voltage Shore Connection (HVSC) Systems - General requirements may be referred to with regard to compatibility assessments between ship-and-shore, coordination of safety interlocks, protection and general guidance.

---end---of---Guidance---note---

302 A separate conductor for protective earthing shall be connected between the hull of the vessel and the ground on the shore. Earth fault protection shall disconnect the shore power supply, both the shore side circuit breaker and the vessel’s main switchboard circuit breaker.

303 Conductors used for system earthing or protective earthing shall be dimensioned so that they can carry the current that will flow in a worst case failure scenario.

A 400 Galvanic isolation

401 For high voltage electrical shore connections, the shore side distribution system and the vessel’s distribution system shall be galvanically separated. When this separation is performed by a transformer, this shall have separate windings for the primary and the secondary side. The transformer can be installed either on shore, or on board.

402 If a power transformer is installed on board for adaptation of the electric shore connection system voltage and the main switchboard voltage, the transformer shall include overvoltage protection, protecting the vessel against lightning impulse over voltages.

403 It is recommended that the same safeguards against overvoltage are applied when the transformer is installed on shore.

Guidance note:
Direct earthing of the lower voltage system, or the use of voltage limitation devices, are considered adequate protection. Alternatively, an earthed screen between the primary and secondary windings may be used.

---end---of---Guidance---note---

A 500 Short circuit strength

501 All circuit breakers and cables used for the electrical shore connection shall be rated for the prospective short circuit currents that may appear at their location in the installation. Interlocks shall be provided in switchboards against simultaneously feeding from the ship’s own generators and the electrical shore connection when the parallel connected short circuit power exceeds the switchboards' short circuit strength. A short time parallel feeding as a “make before break” arrangement is accepted when arranged with automatic disconnection of one of the parallel feeders within 30 s.
The electrical shore connection system may only be used when the short circuit power from shore supply network gives prospective short circuit currents that are less than the rated short circuit making and breaking capacities for switchgear installed in the ship’s distribution system.

A 600 Selectivity / discriminative disconnection

The short circuit protection of equipment and cables between the shore-side supply circuit breaker and the main switchboard’s shore power incoming circuit breaker shall be performed by short circuit protection on both sides of the electrical shore connection. (Short circuit protection in both shore side supply and the main switchboard incoming circuit breaker.)

These rules do not require that the vessel’s distribution system has full discrimination during electrical shore power supply. Limitations in the selectivity shall be described in the system philosophy.

Guidance note:
A vessel’s electrical distribution system is designed for a maximum short circuit current with respect to mechanical strength and circuit breaker rating. The system’s discriminative properties (i.e. that the circuit breaker closest to a short circuit will trip, leaving the healthy part of the vessel’s electrical distribution system operational) depends on maximum and minimum values of the prospective short circuit current of the electric generation and distribution system on board. In order to maintain discriminative protection in the vessel’s distribution system, the shore power supply must have a short circuit capacity within the max and min values of the vessel’s network. Typically when frequency converter is used, the short circuit level may be too low to achieve full discrimination.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

B. Switchgear and interlocks

B 100 Flexible shore to ship connection

There shall be installed equipment enabling efficient cable handling and connection.

The shore connection cable shall be connected by plug and socket connection. Plugs and sockets shall be designed in such a way that incorrect connection is not possible.

Connection or opening of the plug and socket with power on shall not be possible.

The plug and socket system shall be of a type tested design, suitable for marine use.

The plug and socket system shall include a pilot contact for verification of correct connection of the plug and socket. This pilot contact shall be used for interlocks in the circuit breaker control.

The flexible cable shall be terminated close to the ship’s side, and not be used as a part of the fixed cable installation in the vessel. A separate ship-side circuit breaker is not required where the flexible cable is terminated.

B 200 Cable management system

A cable management system shall be installed, which ensures that the mechanical tension in the shore to ship cable is maintained within the design parameters of the cable. The cable shall never become so slack that it may be chafed, nor stretched beyond its design limits. The cable management system shall give alarm at high cable tension to a manned position. At high high tension, the shore connection shall be automatically disconnected. Automatic release of the plug and socket connection is not required.

B 300 Switchgear

Electrical shore connection systems shall be equipped with circuit breakers suitable for isolation and interruption of possible short circuit currents.

The circuit breakers shall be equipped with under-voltage, overcurrent and short circuit trip functions.

High voltage electrical shore connection systems shall be equipped with earthing switches at both sides of the cable connecting the shore to vessel enabling safe discharge of the cable and safe handling of the plug and socket.

The earthing switches shall not be opened before healthy connection of plug and socket is confirmed, and closed if the healthy signal is lost.

Closing of the circuit breakers shall not be possible unless the earthing switches are confirmed open.

B 400 Interlocks

Circuit breakers that are part of the electrical shore connection system, inclusive on board circuit breakers for generators, earthing switches and others, shall have necessary interlocks preventing any hazardous switching operations. These interlocks shall be described in the documentation.
402 The incoming shore power circuit breaker in the main switchboard shall be interlocked against closing unless a check synchronising relay accepts closure, or all generator circuit breakers in the main switchboard is in open position.

403 The incoming shore power circuit breaker in the main switchboard and the shore side supply circuit breaker shall be provided with the following interlocks:

a) Automatic opening of both shore-side and ship-side circuit breakers:
   - upon high high mechanical tension of shore connection cable
   - by missing confirmation of healthy protective earthing connection
   - by missing pilot contact confirmation that the plug and socket is properly connected
   - by emergency disconnection signal
   - short circuit and overcurrent detection on either side of the shore connection cable
   - earth failure detection. (May be selective towards disconnection of earth failures in the on-board distribution system.)
   - under-voltage detection on either side of the electrical shore connection.

b) Operation of the plug and socket:
   - when the plug and socket is manually operated, an attempt to open the plug shall automatically initiate opening of the circuit breakers in both ends of the connection.

404 There shall be an interlock preventing closing of shore circuit breaker unless plug and socket is correctly connected and eventual earthing switches on both shore-side and ship-side are opened.

405 An attempt to insert or withdraw the plug shall initiate opening of circuit breakers. For automatically operated plug and socket, the same feature shall be implemented in the control system.

406 Closure of circuit breakers shall not be possible if confirmation of proper protective earthing connection is not confirmed. If proper earthing connection is lost, the breakers shall open.

407 Activation of protective functions (including high cable tension and emergency disconnection) shall give an alarm to a continuously manned location.

C. Emergency disconnection

C 100 General

101 An independent system for emergency disconnection shall be arranged with emergency stop push buttons.

102 There shall be one emergency stop button in each of the following locations:
   - at the ship’s side where the electrical shore connection is located,
   - where the cable management system is handled,
   - at the shore connection switchboard, and at a continuously manned location.

103 Activation of emergency stop shall result in disconnection of circuit breakers and closing of earthing switches.

104 Opening, or release, of the plug and socket may be a manual operation.

D. Control and monitoring

D 100 General

101 A control system shall be arranged on-board the vessel for the electric shore connection system.

102 This system shall trip both shore side circuit breaker and main switchboard incoming circuit breaker in case of:
   - earth fault
   - short circuit / overcurrent
   - shore side under voltage
   - cable break

103 The control system shall prevent the shore side circuit breaker to close until the ship’s operator manually gives permission. This permission shall not be possible to send unless correct protective earthing, plug/socket connection, and open on-board earthing switch is verified.
104 On the ship side of the electric shore connection systems, at the control position for the shore power incoming circuit breaker, the following instrumentation shall be installed:

- phase sequence indicator
- frequency meters for ship and shore power
- voltmeter
- ampere meter in each phase or fitted with ampere meter switch
- synchronisation equipment.

105 At all locations from where the electrical shore connection or cable management system may be controlled, the following alarms and controls shall be available:

- high and high high tension of the flexible cable
- loss of shore power
- emergency disconnection
- activation of protective functions as earth fault, overcurrent and short circuit.

### E. Installation

**E 100 General**

101 The on board electrical installations for the electrical shore connection system shall comply with the installation requirements given in Pt.4 Ch.8 Sec.10.

102 All high voltage equipment shall be marked with high voltage warning sign.

103 A flexible shore connection cable can be arranged either on board the vessel or situated at key. In both situations a cable handling system must be arranged.

104 All cables installed on board shall be DNV type approved or case by case approved.

### F. Survey and Testing

**F 100 Survey and testing requirements**

101 Before an electrical shore connection installation is put into service or considered ready for operation, it shall be inspected and tested. The aim for this testing shall verify that the physical installation is correct. The installation shall be verified in accordance with relevant documentation. There shall be no hazard to personnel, no inherent fire hazard, and the installation shall function as required for the safe operation of the vessel. This also applies after modifications and alterations.

102 It shall be verified that all equipment is suitably installed with respect to ventilation, ingress protection and accessibility.

103 All equipment shall be verified with respect to proper installation with respect to external wiring and protective earthing.

104 After installation, with termination kit applied, high voltage cables shall be subject to high voltage tests as described in Pt.4 Ch.8 Sec.10 D.

105 All outgoing power circuits from switchboards (cables and consumers) connected during installation shall undergo insulation resistance testing to verify its insulation level towards earth and between phases where applicable (i.e. switchboards assembled onboard.). The insulation resistance tests (megger tests) shall be carried out by means of a suitable instrument applying a DC voltage according to Pt.4 Ch.8 Sec.10 Table D1.

106 Function tests shall be performed in order to evaluate that the installation complies with the requirements in these rules. The function testing shall verify that required interlocks are working properly, and shall cover both the ship-side installation and the shore-side installation.
CHANGES – HISTORIC

Note that historic changes older than the editions shown below have not been included. Older historic changes (if any) may be retrieved through http://www.dnv.com.

July 2012 edition

This is a new document.