E11 Unified requirements for systems with voltages above 1 kV up to 15 kV

(1991)
(Rev.1 May 2001)
(Rev.2 July 2003)
(Rev.3 Feb 2015)
(Corr.1 June 2018)
(Rev.4 Feb 2021)

1. General

1.1 Field of application

The following requirements apply to a.c. three-phase systems with nominal voltage exceeding 1kV, the nominal voltage is the voltage between phases.

f not otherwise stated herein, construction and installation applicable to low voltage equipment generally apply to high voltage equipment.

1.2 Nominal system voltage

The nominal system voltage is not to exceed 15 kV.

Note: Where necessary for special application, higher voltages may be accepted by the Society.

1.3 High-voltage, low-voltage segregation

Equipment with voltage above about 1 kV is not to be installed in the same enclosure as low voltage equipment, unless segregation or other suitable measures are taken to ensure that access to low voltage equipment is obtained without danger.

2. System Design

2.1 Distribution

2.1.1 Network configuration for continuity of ship services

It is to be possible to split the main switchboard into at least two independent sections, by means of at least one circuit breaker or other suitable disconnecting devices, each supplied by at least one generator. If two separate switchboards are provided and interconnected with cables, a circuit breaker is to be provided at each end of the cable.

Services which are duplicated are to be divided between the sections.

Note:

1. Rev.3 of this UR is to be uniformly implemented by IACS Societies from 1 July 2016.

2. Rev.4 of this UR is to be uniformly implemented by IACS Societies for high voltage systems which are installed in new ships contracted for construction on or after 1 July 2022.

3. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and shipbuilder. For further details regarding the date of "contract for construction", refer to IACS Procedural Requirement (PR) No. 29.

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2.1.2 Earthed neutral systems

In case of earth fault, the current is not to be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault.

It is to be assured that at least one source neutral to ground connection is available whenever the system is in the energised mode. Electrical equipment in directly earthed neutral or other neutral earthed systems is to withstand the current due to a single phase fault against earth for the time necessary to trip the protection device.

2.1.3 Neutral disconnection

Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance and for insulation resistance measurement.

2.1.4 Hull connection of earthing impedance

All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, communication and control equipment circuits.

2.1.5 Divided systems

In the systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

2.2 Degrees of protection

2.2.1 General

Each part of the electrical installation is to be provided with a degree of protection appropriate to the location, as a minimum the requirements of IEC 60092-201:2019.

2.2.2 Rotating machines

The degree of protection of enclosures of rotating electrical machines is to be at least IP 23. The degree of protection of terminals is to be at least IP44.

For motors installed in spaces accessible to unqualified personnel, a degree of protection against approaching or contact with live or moving parts of at least IP4X is required.

2.2.3 Transformers

The degree of protection of enclosures of transformers is to be at least IP23.

For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required.

For transformers not contained in enclosures, see para 7.1.

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2.2.4 Switchgear, controlgear assemblies and converters

The degree of protection of metal enclosed switchgear, controlgear assemblies and static convertors is to be at least IP32. For switchgear, control gear assemblies and static converters installed in spaces accessible to unqualified personnel, a degree of protection of at least IP4X is required.

2.3 Insulation

2.3.1 Air clearance

In general, for Non Type Tested equipment phase-to-phase air clearances and phase-to-earth air clearances between non-insulated parts are to be not less than those specified in Table 2.3.1.

Table 2.3.1

Nominal Voltage (kV)	Minimum air clearance (mm)
3(3.3)	55
6 (6.6)	90
10 (11)	120
15	160

Intermediate values may be accepted for nominal voltages provided that the next higher air clearance is observed.

In the case of smaller distances, appropriate voltage impulse test must be applied.

2.3.2 Creepage distances

Creepage distances between live parts and between live parts and earthed metal parts are to be in accordance with IEC 60092-503:2007 for the nominal voltage of the system, the nature of the insulation material and the transient overvoltage developed by switch and fault conditions.

2.4 Protection

2.4.1 Faults on the generator side of circuit breaker

Protective devices are to be provided against phase-to-phase faults in the cables connecting the generators to the main switchboard and against interwinding faults within the generators. The protective devices are to trip the generator circuit breaker and to automatically de-excite the generator.

In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

2.4.2 Faults to earth

Any earth fault in the system is to be indicated by means of a visual and audible alarm. In low impedance or direct earthed systems provision is to be made to automatic disconnect the faulty circuits. In high impedance earthed systems, where outgoing feeders will not be

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isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

Note: Earthing factor is defined as the ratio between the phase to earth voltage of the health phase and the phase to phase voltage. This factor may vary between $(1/\sqrt{3})$ and 1.

A system is defined effectively earthed (low impedance) when this factor is lower than 0.8. A system is defined non-effectively earthed (high impedance) when this factor is higher than 0.8.

2.4.3 Power transformers

Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

2.4.4 Voltage transformers for control and instrumentation

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

2.4.5 Fuses

Fuses are not to be used for overload protection.

2.4.6 Low voltage systems

Lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

i) direct earthing of the lower voltage system.
ii) appropriate neutral voltage limiters.
iii) earthed screen between the primary and secondary windings of transformers.

3. Rotating machinery

3.1 Stator windings of generators

Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

3.2 Temperature detectors

Rotating machinery is to be provided with temperature detectors in their stator windings to actuate a visual and audible alarm in a normally attended position whenever the temperature exceeds the permissible limit.

If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

3.3 Tests

In addition to the tests normally required for rotating machinery, a high frequency high

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voltage test in accordance with IEC 60034-15:2009 is to be carried out on the individual coils in order to demonstrate a satisfactory withstand level of the inter-turn insulation to steep fronted switching surges.

4. Power Transformers

4.1 General

Dry type transformers have to comply with IEC 60076-11:2018. Liquid cooled transformers have to comply with the applicable Parts of the IEC 60076 Series. Oil immersed transformers are to be provided with the following alarms and protections:

- liquid level (Low) - alarm
- liquid temperature (High) - alarm
- liquid level (Low) - trip or load reduction
- liquid temperature (High) - trip or load reduction
- gas pressure relay (High) - trip

5. Cables

5.1 General

Cables are to be constructed in accordance with the IEC 60092-353:2016 and 60092-354:2020 or other equivalent Standard.

6. Switchgear and controlgear assemblies

6.1 General

Switchgear and controlgear assemblies are to be constructed according to the IEC 62271-200:2011 and the following additional requirements.

6.2 Construction

6.2.1 Mechanical construction

Switchgear is to be of metal – enclosed type in accordance with IEC 62271-200:2011 or of the insulation – enclosed type in accordance with the IEC 62271-201:2014.

6.2.2 Locking facilities

Withdrawable circuit breakers and switches are to be provided with mechanical locking facilities in both service and disconnected positions. For maintenance purposes, key locking of withdrawable circuit breakers and switches and fixed disconnectors is to be possible.

Withdrawable circuit breakers are to be located in the service position so that there is no relative motion between fixed and moving portions.

6.2.3 Shutters

The fixed contacts of withdrawable circuit breakers and switches are to be so arranged that in the withdrawable position the live contacts are automatically covered.
Shutters are to be clearly marked for incoming and outgoing circuits. This may be achieved with the use of colours or labels.

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6.2.4 Earthing and short-circuiting

For maintenance purposes an adequate number of earthing and short-circuiting devices is to be provided to enable circuits to be worked upon with safety.

6.2.5 Internal arc Classification (IAC)

Switchgear and controlgear assemblies shall be internal arc classified (IAC).

Where switchgear and controlgear are accessible by authorized personnel only Accessibility Type A is sufficient (IEC 62271-200:2011; Annex AA; AA 2.2). Accessibility Type B is required if accessible by non-authorised personnel.

Installation and location of the switchgear and controlgear shall correspond with its internal arc classification and classified sides (F, L and R).

6.3 Auxiliary systems

6.3.1 Source and capacity of supply

If electrical energy and/or physical energy is required for the operation of circuit breakers and switches, a stored supply of such energy is to be provided for at least two operations of all the components.

However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude shunt tripping provided that alarms are activated upon lack of continuity in the release circuits and power supply failures.

6.3.2 Number of external supply sources

When external source of supply is necessary for auxiliary circuits, at least two external sources of supply are to be provided and so arranged that a failure or loss of one source will not cause the loss of more than one generator set and/or set of essential services.
Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

6.4 High voltage test

A power-frequency voltage test is to be carried out on any switchgear and controlgear assemblies. The test procedure and voltages are to be according to the IEC 62271-200:2011 section 7/ routine test.

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7. Installation

7.1 Electrical equipment

Where equipment is not contained in an enclosure but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the similar marking is to be provided.
An adequate, unobstructed working space is to be left in the vicinity of high voltage equipment for preventing potential severe injuries to personnel performing maintenance activities. In addition, the clearance between the switchboard and the ceiling/deckhead above is to meet the requirements of the Internal Arc Classification according to IEC 62271-200:2011 (see 6.2.5).

7.2 Cables

7.2.1 Runs of cables

In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

7.2.2 Segregation

High voltage cables are to be segregated from cables operating at different voltage ratings each other; in particular, they are not to be run in the same cable bunch, nor in the same ducts or pipes, or, in the same box.
Where high voltage cables of different voltage ratings are installed on the same cable tray, the air clearance between cables is not to be less than the minimum air clearance for the higher voltage side in 2.3.1. However, high voltage cables are not to be installed on the same cable tray for the cables operating at the nominal system voltage of 1 kV and less.

7.2.3 Installation arrangements

High voltage cables, in general, are to be installed on cable trays when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth; otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.

7.2.4 Terminations

Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases are to be separated from earth and from each other by substantial barriers of suitable insulating materials.
High voltage cables of the radial field type, i.e. having a conductive layer to control the electric field within the insulation, are to have terminations which provide electric stress control.

Terminations are to be of a type compatible with the insulation and jacket material of the cable and are to be provided with means to ground all metallic shielding components (i.e. tapes, wires etc).

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7.2.5 Marking

High voltage cables are to be readily identifiable by suitable marking.

7.2.6 Test after installation

Before a new high voltage cable installation, or an addition to an existing installation, is put into service a voltage withstand test is to be satisfactorily carried out on each completed cable and its accessories.

The test is to be carried out after an insulation resistance test.

For cables with rated voltage (U_0/U) above 1.8/3 kV (U_m=3.6 kV) an a.c. voltage withstand test may be carried out upon advice from high voltage cable manufacturer. One of the following test methods to be used:

a) test for 5 min with the phase-to-phase voltage of the system applied between the conductor and the metallic screen/sheath.

b) test for 24 h with the normal operating voltage of the system.

Alternatively, a d.c. test voltage equal to 4 Uo may be applied for 15 minutes.

For cables with rated voltage (U_0/U) up to 1.8/3 kV (U_m=3.6 kV) a d.c. voltage equal to 4 Uo shall be applied for 15 minutes.

After completion of the test, the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge.

An insulation resistance test is then repeated.

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