

concerning
**ELECTRICAL
INSTALLATIONS**



E21 Requirements for uninterruptible power system (UPS) units as
alternative and/or transitional power

Sept 2005

E1 **Governing characteristics of generator**
(1975) **prime movers**

see revised
M 3.2



E2 Deleted (December 1996)



E3 Deleted (December 1996)



E4 Earthing of non-current-carrying parts

(1978)

Deleted in June 2000.



E5 Voltage and frequency variations

(1979)
(Rev.1
Sept.
2005)

1. All electrical appliances supplied from the main or emergency systems are to be so designed and manufactured that they are capable of operating satisfactorily under the normally occurring variations in voltage and frequency.

2. Unless otherwise stated in the national or international standards, all equipment should operate satisfactorily with the variations from its rated value shown in the Tables 1 to 3 on the following conditions.

- (a) For alternative current components, voltage and frequency variations shown in the Table 1 are to be assumed.
- (b) For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table 2 are to be assumed.
- (c) For direct current components supplied by electrical batteries, voltage variations shown in the Table 3 are to be assumed.

3. Any special system, e.g. electronic circuits, whose function cannot operate satisfactorily within the limits shown in the Table should not be supplied directly from the system but by alternative means, e.g. through stabilized supply.

Table 1: Voltage and frequency variations for a.c. distribution systems

Quantity in Operation	Variations	
	Permanent	Transient
Frequency	±5%	±10% (5 sec)
Voltage	+6%, -10%	±20% (1.5 sec)

Table 2: Voltage variations for d.c distribution systems

Parameters	Variations
Voltage tolerance (continuous)	±10%
Voltage cyclic variation deviation	5%
Voltage ripple (a.c. r.m.s. over steady d.c. voltage)	10%

Table 3: Voltage variations for battery systems

Systems	Variations
Components connected to the battery during charging (see Note)	+30%, -25%
Components not connected to the battery during charging	+20%, -25%
Note: Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.	

END

E8 Starting arrangements of internal combustion engines

(1977)
(Rev.1 1996)
(Corr.
Aug 2000)

Deleted in Dec 2003

(E8 has been merged with UR M49 to form a new UR M61 (Dec 2003))



E9
(1988)**Earthing and bonding of cargo tanks/
process plant/piping systems for the control
of static electricity**

- E9.1** The hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of liquids/gases/vapours can be avoided if the resistance between the cargo tanks/process plant/piping systems and the hull of the ship is not greater than 10⁶ ohm.
- E9.2** This value of resistance will be readily achieved without the use of bonding straps where cargo tanks/process plant/piping systems are directly or via their supports, either welded or bolted to the hull of the ship.
- E9.3** Bonding straps are required for cargo tanks/process plant/piping systems which are not permanently connected to the hull of the ship, e.g.
- a) independent cargo tanks;
 - b) cargo tanks/piping systems which are electrically separated from the hull of the ship;
 - c) pipe connections arranged for the removal of spool pieces.
- E9.4** Where bonding straps are required, they should be:
- a) clearly visible so that any shortcomings can be clearly detected;
 - b) designed and sited so that they are protected against mechanical damage and that they are not affected by high resistivity contamination e.g. corrosive products or paint;
 - c) easy to install and replace.
- E9.5** Checks should be made on the resistance to earth during construction of the ship and at subsequent major surveys, supplemented by visual inspection during annual surveys.



E10 Test Specification for Type Approval

(1991)
(Rev. 1
1993)
(Rev. 2
1997)
(Rev.2.1
July 1999)
(Rev.3
May
2001)
(Corr.1
July 2003)
(Rev.4
May 2004)

E10.1 General

This Test specification is applicable, but not confined, to all equipment used for*:

- control, protection and safety;
- internal communication,

E10.2 Testing

These tests are to demonstrate the ability of the equipment to function as intended under the specified testing conditions.

The extent of the testing / i.e. the selection and sequence of carrying out tests and number of pieces to be tested / are to be determined upon examination and evaluation of the equipment or component subject to testing giving due regard to its intended usage.

Equipment is to be tested in its normal position if otherwise not specified in the test specification.

Relevant tests are as listed in the Table.

E10.3 Navigational and Radio Equipment

Test conditions as specified in IEC 60945 (Marine navigational and radiocommunication equipment and systems - General requirements, Methods of testing and required test results) are to be applied for the above mentioned equipment.

Note: * These test requirements are harmonised with IEC 60092-504 “Electrical Installations in Ships - Part 504 : Special features - Control and Instrumentation” and IEC 60533 “Electrical and electronic installations in ships - electromagnetic compatibility”. Electrical and electronic equipment on board ships, required neither by classification rules nor by International Conventions, liable to cause electromagnetic disturbance shall be of type which fulfill the test requirements of test specification items 19 and 20.



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Type testing condition for equipment covered by E10.1

NO.	TEST	PROCEDURE ACC. TO:*	TEST PARAMETERS	OTHER INFORMATION																																	
1	2	3	4	5																																	
1.	Visual inspection	-	-	- conformance to drawings, design data																																	
2.	Performance test	Manufacturer performance test programme based upon specification and relevant Rule requirements.	<ul style="list-style-type: none"> - standard atmosphere conditions - temperature: 25°C ± 10°C - relative humidity: 60% ± 30% - air pressure: 96 KPa ± 10KPa 	<ul style="list-style-type: none"> - confirmation that operation is in accordance with the requirements specified for particular system or equipment; - checking of self-monitoring features; - checking of specified protection against an access to the memory; - checking against effect of unerroneous use of control elements in the case of computer systems. 																																	
3.	External power supply failure	-	<ul style="list-style-type: none"> - 3 interruptions during 5 minutes; - switching-off time 30 s each case 	<ul style="list-style-type: none"> - Verification of: - equipment behaviour upon loss and restoration of supply; - possible corruption of programme or data held in programmable electronic systems, where applicable. 																																	
4.	Power supply variations a) electric	-	<p style="text-align: center;">AC SUPPLY</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Combination</th> <th>Voltage variation permanent %</th> <th>Frequency variation permanent %</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>+6</td> <td>+5</td> </tr> <tr> <td>2</td> <td>+6</td> <td>-5</td> </tr> <tr> <td>3</td> <td>-10</td> <td>-5</td> </tr> <tr> <td>4</td> <td>-10</td> <td>+5</td> </tr> <tr> <td colspan="3" style="text-align: center;">voltage transient</td> </tr> <tr> <td></td> <td>1,5 s</td> <td>frequency transient</td> </tr> <tr> <td></td> <td>%</td> <td>5 s</td> </tr> <tr> <td>5</td> <td>+20</td> <td>%</td> </tr> <tr> <td>6</td> <td>-20</td> <td>+10</td> </tr> <tr> <td></td> <td></td> <td>-10</td> </tr> </tbody> </table>	Combination	Voltage variation permanent %	Frequency variation permanent %	1	+6	+5	2	+6	-5	3	-10	-5	4	-10	+5	voltage transient				1,5 s	frequency transient		%	5 s	5	+20	%	6	-20	+10			-10	
Combination	Voltage variation permanent %	Frequency variation permanent %																																			
1	+6	+5																																			
2	+6	-5																																			
3	-10	-5																																			
4	-10	+5																																			
voltage transient																																					
	1,5 s	frequency transient																																			
	%	5 s																																			
5	+20	%																																			
6	-20	+10																																			
		-10																																			
<p>*Note: column 3 indicates the testing procedure which is normally to be applied. However, equivalent testing procedure may be accepted by the individual Society provided that the Unified Requirements stated in the other columns are fulfilled.</p>																																					

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1	2	3	4	5						
	b) pneumatic and hydraulic		<p style="text-align: center;">DC SUPPLY</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px;">Voltage tolerance continuous</td> <td style="padding: 2px; text-align: center;">± 10%</td> </tr> <tr> <td style="padding: 2px;">Voltage cyclic variation</td> <td style="padding: 2px; text-align: center;">5%</td> </tr> <tr> <td style="padding: 2px;">Voltage ripple</td> <td style="padding: 2px; text-align: center;">10%</td> </tr> </table> <p>Electric battery supply:</p> <ul style="list-style-type: none"> - +30% to -25% for equipment connected to charging battery or as determined by the charging/discharging characteristics, including ripple voltage from the charging device; - +20% to -25% for equipment not connected to the battery during charging. <p>Pressure: ±20% Duration: 15 minutes</p>	Voltage tolerance continuous	± 10%	Voltage cyclic variation	5%	Voltage ripple	10%	
Voltage tolerance continuous	± 10%									
Voltage cyclic variation	5%									
Voltage ripple	10%									
5.	Dry heat	IEC Publication 60068-2-2	<p>Temperature: 55° ± 2°C Duration: 16 hours or Temperature: 70°C ± 2°C Duration: 2 hours (see note 1)</p>	<ul style="list-style-type: none"> - equipment operating during conditioning and testing; - functional test during the last hour at the test temperature; 						



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1	2	3	4	5
6.	Damp heat	IEC Publication 60068-2-30 test D _b	Temperature: 55°C Humidity: 95% Duration: 2 cycles 2 x (12 +12 hours)	<ul style="list-style-type: none"> - measurement of insulation resistance before test; - equipment operating during the complete first cycle and switched off during second cycle except for functional test; - functional test during the first 2 hours of the first cycle at the test temperature and during the last 2 hours of the second cycle at the test temperature; - recovery at standard atmosphere conditions; - insulation resistance measurements and performance test.
7.	Vibration	IEC Publication 60068-2-6 Test F _c	<p>2⁺³₋₀ Hz to 13.2 Hz – amplitude ±1 mm 13.2 Hz to 100 Hz – acceleration ± 0.7 g. For severe vibration conditions such as, e.g. on diesel engines, air compressors, etc.: 2.0 Hz to 25 Hz – amplitude ±1.6 mm 25.0 Hz to 100 Hz – acceleration ± 4.0 g.</p> <p>Note; More severe conditions may exist for example on exhaust manifolds of diesel engines especially for medium and high speed engines.</p>	<ul style="list-style-type: none"> - duration in case of no resonance condition 90 minutes at 30 Hz; - duration at each resonance frequency at which Q ≥ 2 is recorded - 90 minutes; - during the vibration test, operational conditions are to be demonstrated; - tests to be carried out in three mutually perpendicular planes; - it is recommended as guidance that Q does not exceed 5. - if sweep test is chosen in case of several resonance frequencies are detected close to each other, duration of test is to be 120 min.

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1	2	3	4	5
8.	Inclination	Publication IEC 60092-504	<p>Values may be required to be in these cases 40 Hz to 2000 Hz - acceleration $\pm 10.0g$ at 600°C, duration 90 min.</p> <p>Static 22.5°</p> <p>Dynamic 22.5°</p>	<p>a) inclined to the vertical at an angle of at least 22.5°</p> <p>b) inclined to at least 22.5° on the other side of the vertical and in the same plane as in (a),</p> <p>c) inclined to the vertical at an angle of at least 22.5° in plane at right angles to that used in (a),</p> <p>d) inclined to at least 22.5° on the other side of the vertical and in the same plane as in (c).</p> <p>Note: The period of testing in each position should be sufficient to fully evaluate the behaviour of the equipment.</p> <p>Using the directions defined in a) to d) above, the equipment is to be rolled to an angle of 22.5° each side of the vertical with a period of 10 seconds.</p> <p>The test in each direction is to be carried out for not less than 15 minutes</p> <p>On ships for the carriage of liquified gases and chemicals, the emergency power supply is to remain operational with the ship flooded up to a maximum final athwart ship inclination of 30°.</p> <p>Note: These inclination tests are normally not required for equipment with no moving parts.</p>



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1	2	3	4	5																
9.	Insulation resistance	<table border="1"> <thead> <tr> <th data-bbox="391 779 523 965">Rated supply voltage U_n (V)</th> <th data-bbox="523 779 603 965">Test voltage U_n (V)</th> <th colspan="2" data-bbox="603 779 683 965">Min. insulation resistance</th> </tr> <tr> <td data-bbox="391 779 523 846">$U_n \leq 65$</td> <td data-bbox="523 779 603 846">$2 \times U_n$ min. 24V</td> <td data-bbox="603 779 683 846">before test M ohms</td> <td data-bbox="603 779 683 846">after test M ohms</td> </tr> <tr> <td data-bbox="391 846 523 958">$U_n > 65$</td> <td data-bbox="523 846 603 958">500</td> <td data-bbox="603 846 683 913">10</td> <td data-bbox="603 846 683 913">1,0</td> </tr> <tr> <td data-bbox="391 913 523 958"></td> <td data-bbox="523 913 603 958"></td> <td data-bbox="603 913 683 981">100</td> <td data-bbox="603 913 683 981">10</td> </tr> </thead> </table>	Rated supply voltage U_n (V)	Test voltage U_n (V)	Min. insulation resistance		$U_n \leq 65$	$2 \times U_n$ min. 24V	before test M ohms	after test M ohms	$U_n > 65$	500	10	1,0			100	10	<p>Notes to Test No.9</p> <ul style="list-style-type: none"> - For high voltage equipment, reference is made to UR E11. - insulation resistance test is to be carried out before and after: damp heat test, cold test and salt mist test, high voltage test; - between all circuits and earth; - on the supply terminals where appropriate. <p>Note: Certain components e.g. for EMC protection may be required to be disconnected for this test.</p>	
Rated supply voltage U_n (V)	Test voltage U_n (V)	Min. insulation resistance																		
$U_n \leq 65$	$2 \times U_n$ min. 24V	before test M ohms	after test M ohms																	
$U_n > 65$	500	10	1,0																	
		100	10																	
10.	High voltage	<table border="1"> <thead> <tr> <th data-bbox="694 779 842 965">Rated voltage U_n (V)</th> <th data-bbox="842 779 1043 965">Test voltage (A.C. voltage 50 or 60 Hz) (V)</th> </tr> </thead> <tbody> <tr> <td data-bbox="694 779 842 846">Up to 65</td> <td data-bbox="842 779 1043 846">$2 \times U_n + 500$</td> </tr> <tr> <td data-bbox="694 846 842 913">66 to 250</td> <td data-bbox="842 846 1043 913">1500</td> </tr> <tr> <td data-bbox="694 913 842 981">251 to 500</td> <td data-bbox="842 913 1043 981">2000</td> </tr> <tr> <td data-bbox="694 981 842 1048">501 to 690</td> <td data-bbox="842 981 1043 1048">2500</td> </tr> </tbody> </table>	Rated voltage U_n (V)	Test voltage (A.C. voltage 50 or 60 Hz) (V)	Up to 65	$2 \times U_n + 500$	66 to 250	1500	251 to 500	2000	501 to 690	2500	<p>Notes to Test No.10</p> <ul style="list-style-type: none"> - For high voltage equipment, reference is made to UR E11. - separate circuits are to be tested against each other and all circuits connected with each other tested against earth; - printed circuits with electronic components may be removed during the test; - period of application of the test voltage: 1 minute 							
Rated voltage U_n (V)	Test voltage (A.C. voltage 50 or 60 Hz) (V)																			
Up to 65	$2 \times U_n + 500$																			
66 to 250	1500																			
251 to 500	2000																			
501 to 690	2500																			
11.	Cold	IEC Publication 60068-2-1	<p>Temperature: $+5^\circ\text{C} \pm 3^\circ\text{C}$ Duration: 2 hours or Temperature: $-25^\circ\text{C} \pm 3^\circ\text{C}$ Duration: 2 hours (see note 2)</p>	<p>Notes to Test No.11</p> <ul style="list-style-type: none"> - initial measurement of insulation resistance; - equipment not operating during conditioning and testing except for operational test; - operational test during the last hour at the test temperature; - insulation resistance measurement and the operational test after recovery 																

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1	2	3	4	5
12.	Salt mist	IEC Publication 60068-2-52 Test Kb	Four spraying periods with a storage of 7 days after each.	<ul style="list-style-type: none"> - initial measurement of insulation resistance and initial functional test; - equipment not operating during conditioning; - functional test on the 7th day of each storage period; - insulation resistance measurement and performance test 4 to 6h after recovery. (see Note 3)
13.	Electrostatic discharge	IEC 61000-4-2	Contact discharge: 6kV Air discharge: 8kV Interval between single discharges: 1 sec. No. of pulses: 10 per polarity According to level 3 severity standard.	<ul style="list-style-type: none"> - to simulate electrostatic discharge as may occur when persons touch the appliance; - the test is to be confined to the points and surfaces that can normally be reached by the operator; - Performance Criterion B. (See Note 4).
14.	Electromagnetic field	IEC 61000-4-3	Frequency range: 80 MHz to 2 GHz Modulation**: 80% AM at 1000Hz Field strength: 10V/m Frequency sweep rate: $\leq 1.5 \times 10^{-3}$ decades/s (or 1%/3 sec) According to level 3 severity standard.	<ul style="list-style-type: none"> - to simulate electromagnetic fields radiated by different transmitters; - the test is to be confined to the appliances exposed to direct radiation by transmitters at their place of installation. - Performance criterion A (See Note 5) ** If for tests of equipment an input signal with a modulation frequency of 1000 Hz is necessary a modulation frequency of 400 Hz may be chosen.



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1	2	3	4	5
15	Conducted low Frequency	IEC 60533	<p>AC: Frequency range :rated frequency to 200th harmonic; Test voltage (rms) : 10% of supply to 15th harmonic reducing to 1% at 100th harmonic and maintain this level to the 200th harmonic, max 2 W.</p> <p>DC: Frequency range : 50 Hz - 10 kHz; Test voltage (rms) :10% of supply max. 2 W</p>	<ul style="list-style-type: none"> - to stimulate distortions in the power supply system generated for instance, by electronic consumers and coupled in as harmonics; - performance criterion A (see Note 5).
16	Conducted Radio Frequency	IEC 61000-4-6	<p>AC, DC, I/O ports and signal/control lines: Frequency range : 150 kHz-80 MHz Amplitude : 3 V rms (See Note 6) Modulation ***: 80% AM at 1000 Hz Frequency sweep range: ≤ 1.5 x 10⁻³ decades/s (or 1%/3sec.) According to level 2 severity standard</p>	<ul style="list-style-type: none"> - Equipment design and the choice of materials is to stimulate to stimulate electromagnetic fields coupled as high frequency into the test specimen via the connecting lines. - performance criterion A (see Note 5). *** If for tests of equipment an input signal with a modulation frequency of 1000 Hz is necessary a modulation frequency of 400 Hz may be chosen.
17	Burst/Fast Transients	IEC 61000-4-4	<p>Single pulse time: 5ns (between 10% and 90% value) Single pulse width: 50 ns (50% value) Amplitude (peak): 2kV line on power supply port/earth: 1kV on I/O data control and communication ports (coupling clamp) Pulse period: 300 ms; Burst duration: 15 ms; Duration/polarity: 5 min According to level 3 severity standard.</p>	<ul style="list-style-type: none"> - arcs generated when actuating electrical contacts; - interface effect occurring on the power supply, as well as at the external wiring of the test specimen; - performance criterion B (see Note 4).



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1	2	3	4	5
18	Surge/ voltage	IEC 61000-4-5	Pulse rise time: 1.2 μ Vs (between 10% and 90% value) Pulse width: 50 μ Vs (50% value) Amplitude (peak) : 1kV line/earth; 0.5kV line/line Repetition rate: \geq 1 pulse/min No of pulses: 5 per polarity Application: continuous According to level 2 severity standard.	<ul style="list-style-type: none"> - interference generated for instance, by switching "ON" or "OFF" high power inductive consumers; - test procedure in accordance with figure 10 of the standard for equipment where power and signal lines are identical; - performance criterion B (see Note 4).
19	Radiated Emission	CISPR 16-1, 16-2	<ul style="list-style-type: none"> - For equipment installed in the bridge and deck zone. Frequency range: Limits: 0.15-0.3 MHz 80-52dBμV/m 0.3-30 MHz 50-34dBμV/m 30 - 2000MHz 54dBμV/m except for: 156-165 MHz 24 dBμV/m For equipment installed in the general power distribution zone. Frequency range: Limits: 0.15 - 30 MHz 80 - 50 dBμV/m 30-100 MHz 60-54 dBμV/m 100 - 2000 MHz 54 dBμV/m except for: 156-165 MHz 24 dBμV/m 	<ul style="list-style-type: none"> - procedure in accordance with the standard but distance 3 m between equipment and antenna

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1	2	3	4	5
20	Conducted Emission	CISPR 16-1, 16-2	<p>For equipment installed in the bridge and deck zone.</p> <p>Frequency range: Limits: 10-150kHz 96 -50dBμV 150-350 kHz 60- 50 dBμV 350 kHz - 30 MHz 50 dBμV</p> <p>For equipment installed in the general power distribution zone.</p> <p>Frequency range: Limits: 10-150 kHz 120 69 dBμV 150-500kHz 79dBμV 0.5 - 30 MHz 73 dBμV</p>	
21	Flame retardant	IEC 60092-101 or IEC 60695-2-2	<p>Flame application: 5 times 15 s each. Interval between each application: 15s or 1 time 30s.</p> <p>Test criteria based upon application.</p>	<p>- the burnt out or damaged part of the specimen by not more than 60 mm long.</p> <p>- Equipment design and the choice of materials is to reduce the likelihood of fire ensuring that:</p> <p>a) where the electrical energised part can cause ignition and fire it is contained within the bounds of the enclosure of the electrotechnical product;</p> <p>b) the design, material(s) and construction of the enclosure minimizes, as far as practicable, any internal ignition causing ignition of adjacent materials; and where surfaces of the electrotechnical products can be exposed to external fire they do not contribute to the fire growth.</p>



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Notes:

1. Equipment to be mounted in consoles, housing etc. together with other equipment are to be tested with 70°C.
2. For equipment installed in non-weather protected locations or cold locations test is to be carried out at -25°C.
3. Salt mist test is to be carried out for equipment installed in weather exposed areas.
4. Performance Criterion B: (For transient phenomena): The EUT shall continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self recoverable is however allowed but no change of actual operating state or stored data is allowed.
5. Performance Criterion A: (For continuous phenomena) : The Equipment Under Test shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in relevant equipment standard and the technical specification published by the manufacturer.
6. For equipment installed on the bridge and deck zone, the test levels shall be increased to 10V rms for spot frequencies in accordance with IEC 60945 at 2,3,4, 6.2, 8.2, 12.6, 16.5, 18.8, 22, 25 MHz.



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

1991
(Rev. 1
May
2001)
(Rev.2
July
2003)

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.

If 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.

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.



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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 Publication 60092-201.

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.

2.2.4 Switchgear, controlgear assemblies and converters

The degree of protection of metal enclosed switchgear, controlgear assemblies and static converters 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.



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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 for standard components are to be in accordance with relevant IEC Publications for the nominal voltage of the system, the nature of the insulation material and the transient overvoltage developed by switch and fault conditions.

For non-standardised parts within the busbar section of a switchgear assembly, the minimum creepage distance is to be at least 25 mm/kV and behind current limiting devices, 16mm/kV.

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 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.



E11

cont d

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 voltage test in accordance with IEC Publication 60034-15 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.



E11

cont d

4. Power Transformers**4.1 General**

Dry type transformers have to comply with IEC Publication 60726. Liquid cooled transformers have to comply with IEC Publication 60076. 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 I.E.C Publication 60092-353 and 60092-354 or other equivalent Standard.

6. Switchgear and controlgear assemblies**6.1 General**

Switchgear and controlgear assemblies are to be constructed according to the I.E.C Publication 60298 and the following additional requirements.

6.2 Construction**6.2.1 Mechanical construction**

Switchgear is to be of metal — enclosed type in accordance with I.E.C Publication 60298 or of the insulation — enclosed type in accordance with the I.E.C Publication 60466.

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.

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.

6.3 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. ►

E11

cont d

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 Publication 60298.

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.

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 carrier plating 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.



E11
cont'd**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).

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.

When a d.c. voltage withstand test is carried out, the voltage is to be not less than:

- 1.6 (2.5 U_0 + 2kV) for cables of rated voltage (U_0) up to and including 3.6 kV, or
- 4.2 U_0 for higher rated voltages

where U_0 is the rated power frequency voltage between conductor and earth or metallic screen, for which the cable is designed.

The test voltage is to be maintained for a minimum of 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.

Alternatively, an a.c. voltage withstand test may be carried out upon advice from high voltage cable manufacturer at a voltage not less than normal operating voltage of the cable and it is to be maintained for a minimum of 24 hours.

Note: Tests according to those specific in IEC Publication 60502 will be considered adequate too.



E12 Electrical Equipment allowed in paint stores and in the enclosed spaces leading to paint stores

(1994)
(Corr.
1997)
(Rev.1
May
2001)

1. Electrical equipment is to be installed in paint stores and in ventilation ducts serving such spaces only when it is essential for operational services.

Certified safe type equipment of the following type is acceptable ;

- a. intrinsically safe Exi
- b. flameproof Exd
- c. pressurised Exp
- d. increased safety Exe
- e. special protection Exs

Cables (through-runs or terminating cables) of armoured type or installed in metallic conduits are to be used.

2. The minimum requirements for the certified safe type equipment are as follows:
 - explosion group II B
 - temperature class T3
3. Switches, protective devices, motor control gear of electrical equipment installed in a paint store are to interrupt all poles or phases and preferably are to be located in non-hazardous space.
4. In the areas on open deck within 1m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical ventilation outlets, the following electrical equipment may be installed:
 - electrical equipment with the type of protection as permitted in paint stores or
 - equipment of protection class Exn or
 - appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature or
 - appliances with simplified pressurised enclosures or vapour-proof enclosures (minimum class of protection IP55) whose surface does not reach unacceptably high temperature
 - cables as specified in clause 1.
5. The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that :
 - the door to the paint store is a gastight door with self-closing devices without holding back arrangements,
 - the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area,
 - warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

Note:

The paint stores and inlet and exhaust ventilation ducts under Clause 1 are classified as Zone-1-and areas on open deck under Clause 4 as Zone 2, as defined in IEC standard 60092-502, Electrical Installation in ships-part 502: Tankers-special features.

A watertight door may be considered as being gastight.



E13 Test requirements for Rotating Machines

(1996)
(Rev.1
May
2001)
(Corr. 1
May
2004)

1. GENERAL

All machines are to be tested by the manufacturer.

Manufacturer s test records are to be provided for machines for essential services, for other machines they are to be available upon request.

All tests are to be carried out according to IEC Publication 60092-301.

All machines of 100kW and over, intended for essential services, are to be surveyed by the Society during test and, if appropriate, during manufacturing.

Note: An alternative survey scheme may be agreed by the Society with the manufacturer whereby attendance of the Surveyor will not be required as required above.

2. SHAFT MATERIAL

Shaft material for electric propulsion motors and for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by the Society.

Shaft material for other machines is to be in accordance with recognised international or national standard.

E13 3 TESTS

cont d

Type tests are to be carried out on a prototype machine or on the first of a batch of machines, and routine tests carried out on subsequent machines in accordance with Table 1.

Note: Test requirements may differ for shaft generators, special purpose machines and machines of novel construction.

Table 1

No	Tests	A.C. Generators		Motors	
		Type test ¹⁾	Routine test ²⁾	Type test ¹⁾	Routine test ²⁾
1.	Examination of the technical documentation, as appropriate and visual inspection	x	x	x	x
2.	Insulation resistance measurement	x	x	x	x
3.	Winding resistance measurement	x	x	x	x
4.	Verification of the voltage regulation system	x	x ³⁾		
5.	Rated load test and temperature rise measurements	x		x	
6.	Overload/overcurrent test	x	x ⁴⁾	x	x ⁴⁾
7.	Verification of steady short circuit conditions ⁵⁾	x			
8.	Overspeed test	x	x	x ⁶⁾	x ⁶⁾
9.	Dielectric strength test	x	x	x	x
10.	No-load test	x	x	x	x
11.	Verification of degree of protection	x		x	
12.	Verification of bearings	x	x	x	x

- 1) Type tests on prototype machine or tests on at least the first batch of machines.
- 2) The report of machines routine tested is to contain the manufacturer s serial number of the machine which has been type tested and the test result.
- 3) Only functional test of voltage regulator system.
- 4) Only applicable for machine of essential services rated above 100kW.
- 5) Verification of steady short circuit condition applies to synchronous generators only.
- 6) Not applicable for squirrel cage motors.

E13

cont d

4 DESCRIPTION OF THE TEST**4.1 Examination of the technical documentation, as appropriate and visual inspection****4.1.1 Examination of the technical documentation**

Technical documentation of machines rated at 100kW and over is to be available for examination by the Surveyor.

4.1.2 Visual inspection

A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation.

4.2 Insulation resistance measurement

Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

- a) all current carrying parts connected together and earth,
- b) all current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.

The minimum values of test voltages and corresponding insulation resistances are given in Table 2. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

Table 2

Related Voltage U_n (V)	Minimum Test Voltage (V)	Minimum Insulation Resistance ($M\Omega$)
$U_n \leq 250$	$2 \times U_n$	1
$250 < U_n \leq 1000$	500	1
$1000 < U_n \leq 7200$	1000	$(U_n / 1000) + 1$
$7200 < U_n \leq 15000$	5000	$(U_n / 1000) + 1$

4.3 Winding resistance measurement

The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.



E13 4.4 Verification of the voltage regulation system

cont d

The alternating current generator, together with its voltage regulation system, is to be verified that, at all loads from no-load running to full load, the rated voltage at the rated power factor is maintained under steady conditions within $\pm 2.5\%$. These limits may be increased to $\pm 3.5\%$ for emergency sets.

When the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of specified current and power factor, the voltage is not to fall below 85% nor exceed 120% of the rated voltage.

The voltage of the generator is then to be restored to within plus or minus 3% of the rated voltage for the main generator sets in not more than 1.5 s. For emergency sets, these values may be increased to plus or minus 4% in not more than 5 s, respectively.

In the absence of precise information concerning the maximum values of the sudden loads, the following conditions may be assumed: 60% of the rated current with a power factor of between 0.4 lagging and zero to be suddenly switched on with the generator running at no load, and then switched off after steady - state conditions have been reached.

4.5 Rated load test and temperature rise measurements

The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC Publication 60034-1, or by means of a combination of other tests.

The limits of temperature rise are those specified in Table 1 of IEC Publication 60034-1 adjusted as necessary for the ambient reference temperatures specified in UR M40.

4.6 Overload/overcurrent tests

Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque as required in IEC Publication 60034-1. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).

4.7 Verification of steady short-circuit conditions

It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least three times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which may be fitted in a tripping device for discrimination purposes.

4.8 Overspeed test

Machines are to withstand the overspeed test as specified in IEC Publication 60034-1. This test is not applicable for squirrel cage motors.

4.9 Dielectric strength test

Machines are to withstand a dielectric test as specified in IEC Publication 60034-1.

For high voltage machine an impulse test is to be carried out on the coils according to UR E11.



E13

cont d

4.10 No load test

Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

4.11 Verification of degree of protection

As specified in IEC Publication 60034-5.

4.12 Verification of bearings

Upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by the Classification Society Surveyor, to establish that the shaft is correctly seated in the bearing shells.



E15

(Nov.
1999)
(Rev.1
May
2004)
(Rev.2
Feb
2006)

Electrical Services Required to be Operable Under Fire Conditions and Fire Resistant Cables

1. Electrical services required to be operable under fire conditions are as follows:
 - Control and power systems to power-operated fire doors and status indication for all fire doors
 - Control and power systems to power-operated watertight doors and their status indication
 - Emergency fire pump
 - Emergency lighting
 - Fire and general alarms
 - Fire detection systems
 - Fire-extinguishing systems and fire-extinguishing media release alarms
 - Low location lighting
 - Public address systems
 - Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion

2. Where cables for services specified in 1. including their power supplies pass through high fire risk areas, and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following measures:

- a) Cables being of a fire resistant type complying with IEC 60331-31 for cables of greater than 20 mm overall diameter, otherwise 60331-21, are installed and run continuous to keep the fire integrity within the high fire risk area, see Figure 1.
- b) At least two-loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

Systems that are self monitoring, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

E15

(cont'd)

Notes:

a) For the purpose of E15 application, the definition for “high fire risk areas” is the following:

- (i) Machinery spaces as defined by Chap. II-2 / Reg. 3.30 of SOLAS.
- (ii) Spaces containing fuel treatment equipment and other highly flammable substances
- (iii) Galley and Pantries containing cooking appliances
- (iv) Laundry containing drying equipment
- (v) Spaces as defined by paragraphs (8), (12), and (14) of Chap. II-2 / Reg. 9.2.2.3.2.2 of SOLAS for ships carrying more than 36 passengers

b) Fire resistant type cables should be easily distinguishable.

c) For special cables, requirements in the following standards may be used:

IEC60331-23: Procedures and requirements – Electric data cables

IEC60331-25: Procedures and requirements – Optical fibre cables

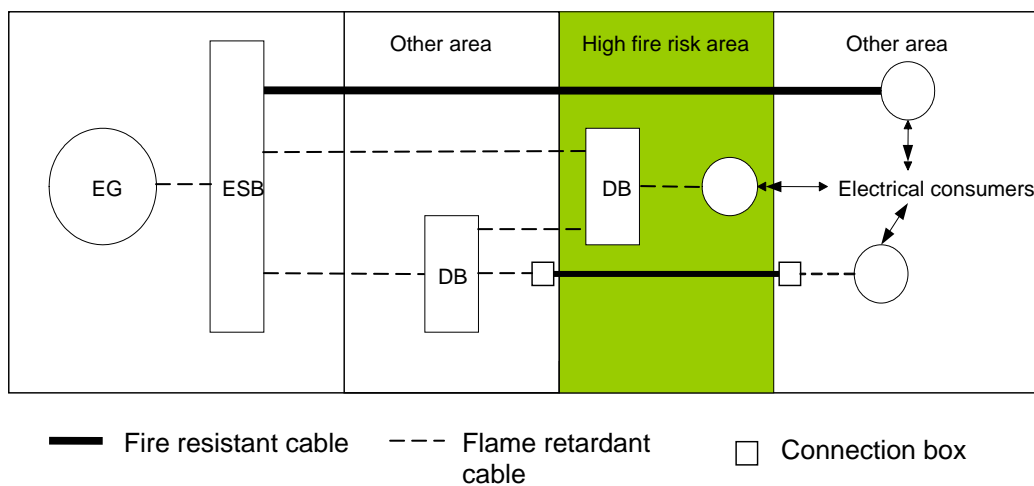


Figure 1

End of
Document

E16 Cable trays/protective casings made of plastics materials

(June
2002)

1. General requirement

Cable trays/protective casings made of plastics materials are to be type tested ¹⁾.

Note: "Plastics" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fibre reinforced plastics - FRP.
"Protective casing" means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

2. Installation Requirements

2.1. Cable trays/protective casings made of plastics materials are to be supplemented by metallic fixing and straps such that in the event of a fire they, and the cables affixed, are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route.

Note: When plastics cable trays/protective casings are used on open deck, they are additionally to be protected against UV light.

2.2. The load on the cable trays/protective casings is to be within the Safe Working Load (SWL). The support spacing is not to be greater than the Manufacturer's recommendation nor in excess of spacing at the SWL test. In general the spacing is not to exceed 2 meters.

Note: The selection and spacing of cable tray/protective casing supports are to take into account:

- cable trays/protective casings' dimensions;
- mechanical and physical properties of their material;
- mass of cable trays/protective casings;
- loads due weight of cables, external forces, thrust forces and vibrations;
- maximum accelerations to which the system may be subjected;
- combination of loads .

2.3. The sum of the cables' total cross-sectional area, based on the cables' external diameter, is not to exceed 40% of the protective casing's internal cross-sectional area. This does not apply to a single cable in a protective casing.

Note:

1) Cable trays/protective casings made of plastic materials are to be type tested in accordance with the Type Approval Procedure applied by the Society. For guidance on testing, refer to REC 73.



E17 Generators and generator systems, having the ship's propulsion machinery as their prime mover, not forming part of the ship's main source of electrical power.

(June
2002)

Generators and generator systems, having the ship's propulsion machinery as their prime mover but not forming part of the ship's main source of electrical power¹ may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions provided that:

1. there are sufficient and adequately rated additional generators fitted, which constitute the main source of electrical power required by SOLAS, meeting the requirements of IEC 60092-201² paragraph 6.2.3.
2. arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power required by SOLAS, in compliance with paragraph 2.2 of SC 157 and also upon the frequency variations exceeding $\pm 10\%$ of the limits specified below.
3. within the declared operating range of the generators and/or generator systems the specified limits for the voltage variations in IEC 60092—301³ and the frequency variations in UR E5 can be met.
4. the short circuit current of the generator and/or generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.
5. where considered appropriate, load shedding arrangements are fitted to meet the requirements of paragraph 2.3 of SC 157.
6. on ships having remote control of the ship's propulsion machinery from the navigating bridge means are provided, or procedures be in place, so as to ensure that supplies to essential services are maintained during manoeuvring conditions in order to avoid a blackout situation⁴.

Notes:

1. Such generator systems are those whose operation does not meet the requirements of IEC 60092-201, paragraph 6.2.3.
2. IEC 60092-201 Electrical installations in ships - part 201: System design - General
3. IEC 60092-301 Electrical installations in ships - part 301: Equipment — Generators and motors.
4. A 'blackout situation' means that the main and auxiliary machinery installations, including the main power supply, are out of operation but the services for bringing them into operation (e.g. compressed air, starting current from batteries etc.) are available.



E18 Recording of the Type, Location and Maintenance Cycle of Batteries

(July 2003)

1. Where batteries are fitted for use for essential (UI SC134) and emergency services a schedule of such batteries is to be compiled and maintained. The schedule, which is to be reviewed by the Society, is to include at least the following information regarding the battery(ies):
 - Type and manufacturer's type designation.
 - Voltage and ampere-hour rating.
 - Location.
 - Equipment and/or system(s) served.
 - Maintenance/replacement cycle dates.
 - Date(s) of last maintenance and/or replacement.
 - For replacement batteries in storage, the date of manufacture and shelf life.¹

2. Procedures are to be put in place to ensure that where batteries are replaced that they are of an equivalent performance type.

3. Where vented² type batteries replace valve-regulated sealed³ types, it is to be ensured that there is adequate ventilation⁴ and that the Society's requirements relevant to the location and installation of vented types batteries are complied with.

4. Details of the schedule and of the procedures are to be included in the ship's safety management system and be integrated into the ship's operational maintenance routine as appropriate⁵ to be verified by the Society's surveyor.

¹Shelf life is the duration of storage under specified conditions at the end of which a battery retains the ability to give a specified performance.

²A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

³A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

⁴The ventilation arrangements for installation of vented type batteries which have charging power higher than 2kW are to be such that the quantity of air expelled is at least equal to:

$$\begin{array}{rcl}
 Q & = & 110/n \quad \text{where} \\
 n & = & \text{number of cells in series} \\
 I & = & \text{maximum current delivered by the charging equipment during gas formation, but not less than 25 per cent} \\
 & & \text{of the maximum obtainable charging current in amperes} \\
 Q & = & \text{quantity of air expelled in litres/hr.}
 \end{array}$$

The ventilation rate for compartments containing valve-regulated batteries may be reduced to 25 per cent of that given above.

⁵See section 10 of the IMO ISM Code.



E19 Ambient Temperatures for Electrical Equipment installed in environmentally controlled spaces

(July
2003)
(Rev.1
Sept.
2005)

1. Where electrical equipment is installed within environmentally controlled spaces the ambient temperature for which the equipment is to be suitable may be reduced from 45°C and maintained at a value not less than 35°C provided:

- the equipment is not for use for emergency services.
- temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is capable of satisfactorily maintaining the design temperature.
- the equipment is able to be initially set to work safely within a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved; the cooling equipment is to be rated for a 45°C ambient temperature.
- audible and visual alarms are provided, at a continually manned control station, to indicate any malfunction of the cooling units.

2. In accepting a lesser ambient temperature than 45°C, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length.

3. The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with UI SC 134 and to be subject to survey in accordance with the requirements of the relevant Society.

END

E20 Installation of electrical and electronic equipment (May 2004) **in engine rooms protected by fixed water-based local application fire-fighting systems (FWBLAFFS)**

Definitions:

Protected space:

- Is a machinery space where a FWBLAFFS is installed.

Protected areas:

- Areas within a protected space which is required to be protected by FWBLAFFS.

Adjacent areas:

- Areas, other than protected areas, exposed to direct spray.
- Areas, other than those defined above, where water may extend.

See also Fig. 1

Unless it is essential for safety or operational purposes, electrical and electronic equipment is not to be located within areas protected by FWBLAFFS and in adjacent areas where water may extend.

The electrical and electronic equipment located within areas protected by FWBLAFFS and those within adjacent areas exposed to direct spray are to have a degree of protection not less than IP44.

Electrical and electronic equipment within adjacent areas not exposed to direct spray may have a lower degree of protection provided evidence of suitability for use in these areas is submitted taking into account the design and equipment layout, e.g. position of inlet ventilation openings, filters, baffles, etc. to prevent or restrict the ingress of water mist/spray into the equipment. The cooling airflow for the equipment is to be assured.

Note

1. Additional precautions may be required to be taken in respect of:

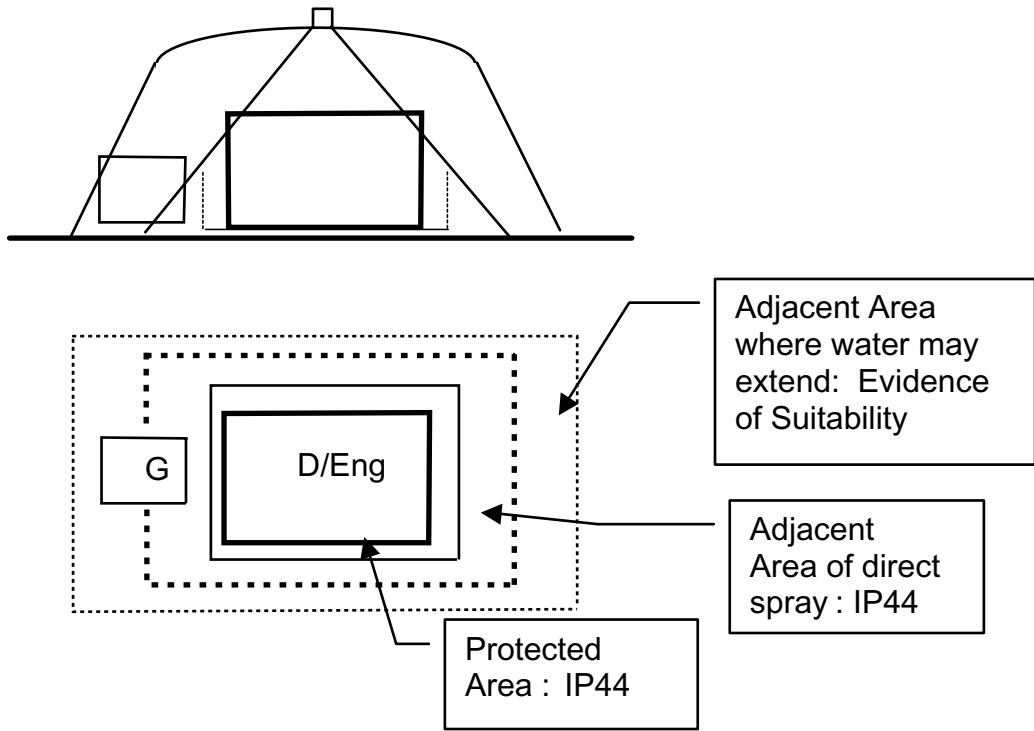
- a. tracking as the result of water entering the equipment
- b. potential damage as the result of residual salts from sea water systems
- c. high voltage installations
- d. personnel protection against electric shock

Equipment may require maintenance after being subjected to water mist/spray.



E20
(Cont d)

Fig. 1



E21 Requirements for uninterruptible power system (UPS) units as alternative and/or transitional power

(Sept. 2005)

Scope:

These requirements to UPS units, as defined in IEC 62040, apply when providing an alternative power supply or transitional power supply to services as defined in SOLAS Chapter II-1, Regulations 42 and 43.

A UPS unit complying with these requirements may provide an alternative power supply as an accumulator battery in terms of being an independent power supply for services defined in SOLAS Chapter II-1, Regulation 42, 2.3 or 43, 2.4.

Definitions:

Uninterruptible Power System (UPS) - combination of converters, switches and energy storage means, for example batteries, constituting a power system for maintaining continuity of load power in case of input power failure [IEC 62040:1999]

Off-line UPS unit - a UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside preset limits. This transition will invariably result in a brief (typically 2 to 10 ms) break in the load supply.

Line interactive UPS unit - an off-line UPS unit where the bypass line switch to stored energy power when the input power goes outside the preset voltage and frequency limits.

On-line UPS unit - a UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the supply input failing or going outside preset limits.

1. Design and construction

1.1 UPS units are to be constructed in accordance with IEC 62040, or an acceptable and relevant national or international standard.

1.2 The operation of the UPS is not to depend upon external services.

1.3 The type of UPS unit employed, whether off-line, line interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

1.4 An external bypass is to be provided.

1.5 The UPS unit is to be monitored and audible and visual alarm is to be given in a normally attended location for

- power supply failure (voltage and frequency) to the connected load,
- earth fault,
- operation of battery protective device,
- when the battery is being discharged, and
- when the bypass is in operation for on-line UPS units.

E21**2. Location**

cont

2.1 The UPS unit is to be suitably located for use in an emergency.

2.2 UPS units utilising valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040 or an acceptable and relevant national or international standard.

3. Performance

3.1 The output power is to be maintained for the duration required for the connected equipment as stated in SOLAS Chapter II-1, Regulation 42 or 43.

3.2 No additional circuits are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in the regulations.

3.3 On restoration of the input power, the rating of the charge unit shall be sufficient to recharge the batteries while maintaining the output supply to the load equipment.

4. Testing and survey

4.1 UPS units of 50 kVA and over are to be surveyed by the Society during manufacturing and testing.

4.2 Appropriate testing is to be carried out to demonstrate that the UPS unit is suitable for its intended environment. This is expected to include as a minimum the following tests:

- Functionality, including operation of alarms;
- Temperature rise;
- Ventilation rate;
- Battery capacity.

4.3 Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical test.

END