Guideline No.E-15 (201705)

E-15 Uninterruptible Power Systems (UPS)

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Foreword

This Guideline is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

This Guideline is published and updated by CCS and can be found through http://www.ccs.org.cn. Comments or suggestions can be sent by email to ps@ccs.org.cn.

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"IEC 62040-1:2008" is modified to "IEC 62040-1:2008+AMD1:2013 CSV".

"IEC 62040-3:1999" is modified to "IEC 62040-3:2011".

CONTENTS

Uninterruptible Power Systems (UPS)

1 Application

1.1 The Guideline applies to the approval and inspection of the uninterruptible power system (UPS) installed on the marine ship and offshore installations.

1.2 Such equipment includes:

The power supply substituting the emergency power supply specified in Section 9 of Chapter 3 in Part Four of the *Rules for Classification of Sea-Going Steel Ships* or the temporary emergency power supply, supplying power to the load specified in Articles 2.2.2.1 (3) and 2.2.3.1 (4) of Chapter 2 in Part Four of the *Rules for Classification of Sea-Going Steel Ships.*

1.3 The following UPS, if requiring approval by CCS, should meet the applicable requirement of the Guideline:

1.3.1 The backup power supply for the automation system required in 2.1.6.1 of Chapter 2 in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*, supplying power to the safety system, alarm system, and the control system (such as the automation system of the power station) that requires power supply in case of power loss of the power supply mentioned above.

1.3.2 The backup power supply for the computer system required in Annex "Guideline on Marine Computer Application and Inspection" in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*, supplying power to the computer system.

2 Basis for approval and inspection

2.1 *CCS Rules for Classification of Sea-Going Steel Ships*

2.2 IEC62040-1:2008+AMD1:2013 CSV *Uninterruptible Power Systems (UPS) – Part 1: General and Safety Requirements for UPS*

2.3 IEC62040-3:2011 *Uninterruptible Power Systems (UPS) – Part 3: Method of Specifying the Performance and Test Requirements*

2.4 CCS GD22-2015: *Guideline for Type Approval Test of Electrical and Electronic Products* (current valid version))

3 Definitions

The terms and definitions specified in the above-mentioned inspection bases apply to the Guideline. To facilitate the compilation and use, the Guideline directly cites or supplements the following definitions.

3.1 Rules for Classification of Sea-Going Steel Ships

It means the *CCS Rules for Classification of Sea-Going Steel Ships.*

3.2 Uninterruptible power systems (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

3.3 UPS unit

A complete UPS should consist of at least the following functional units: The UPS inverter, UPS rectifier and battery or other energy storage device. Such units should be operated together with other UPS units to form a parallel UPS or redundancy UPS.

3.4 Converter

Operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

3.5 DC energy storage system

System consisting of single or multiple devices (typically batteries) designed to provide the required cell

3.6 DC link

Direct current power interconnection between the rectifier or rectifier/charger and the inverter functional unit.

3.7 Valve-regulated sealed battery

Secondary cell which is closed under normal conditions, but has an arrangement to allow gas to escape if the internal pressure exceeds a predetermined value. The battery cannot normally receive addition to the electrolyte

3.8 Vented battery

Secondary cell having a cover provided with an opening through which gaseous products may escape

3.9 UPS switch

UPS switch consisting of one or more switches used to transfer power from one source to another

The term of the UPS switch applies to all the electrical switches acting as the functional UPS units (depending also on its application), including the circuit breaker, bypass switch, disconnector, load changeover switch and interconnection switch. Such switches coordinate with other functional

UPS units to maintain the load power continuity. Other switches or circuit breakers, such as the traditional main power supply distribution panel, rectifier input switch, battery switch, or other general circuit breaker or switch used for convenience, are not covered in the Guideline. For details, see Annex "C-UPS Switch" of IEC62040-3.

3.10 Bypass

Power path alternative to the indirect a.c. converter

3.11 Normal load

Load that in normal mode of operation, approximates as close as possible to the most severe conditions of normal use in accordance with the manufacturer’s operating instructions

3.12 Normal mode of UPS operation

Stable mode of operation that the UPS finally attains when supplied under the following conditions:

3.12.1 The main power supply is available and in the prescribed deviation;

3.12.2 The battery has been charged or recharged in the given restored energy time;

3.12.3 It runs or may run continuously;

3.12.4 Phase locking is valid (if any);

3.12.5 The load is within the given range;

3.12.6 The output voltage is within the given tolerance;

3.12.7 The bypass is valid and in the specified deviation at places where the UPS applies.

3.13 Stored energy mode of UPS operation (generally called the "Battery operation")

Operation of the UPS when supplied under the following conditions:

3.13.1 The main power supply is interrupted or exceeds the given deviation;

3.13.2 The DC energy storage system starts running;

3.13.3 The load is within the given range;

3.13.4 The output voltage is within the given deviation;

3.14 Bypass mode of UPS operation

State the UPS attains when operating the load supplied via the bypass only

3.15 UPS double conversion (generally called the "online mode")

Any UPS operation, where continuity of load power is maintained by a UPS inverter, with energy from the d.c. link in normal mode of operation or from the energy storage system in stored energy mode of operation. The output voltage and frequency are independent of input voltage and frequency conditions

3.16 UPS double conversion with bypass

UPS operation as for UPS double conversion with the following addition. Under temporary or continuous output overload conditions, or in the case of UPS rectifier/inverter failure, the load is temporarily supplied with power via the alternative bypass path. Under bypass operation, the load may be affected by input supply voltage and frequency variations

3.17 UPS line interactive operation

Any UPS operation where, in normal mode of operation, the continuity of load power is maintained by the use of a UPS inverter or a power interface while conditioning primary power at the input supply frequency

When the a.c. input voltage and/or frequency is out of UPS preset variation limits, the UPS inverter and battery maintain continuity of load power in stored energy mode of operation within the stated output voltage/frequency tolerances

3.18 UPS line interactive operation with bypass

UPS operation as for UPS line interactive with the following addition. In the event of a UPS functional unit failure, the load may be transferred to an alternative bypass path fed from primary or standby power. In bypass mode of operation, the load may be affected by input supply voltage and frequency variations

3.19 UPS passive standby operation

Any UPS operation where, in normal mode of operation, the load is primarily supplied by primary power and is subject to input voltage and frequency variations within stated limits. When the a.c. input supply is outside UPS design load tolerances, the UPS inverter is activated from the battery, and maintains continuity of load power in stored energy mode of operation

3.20 Fixed equipment

Stationary equipment which is fastened or otherwise secured at a specific location

3.21 Service access area

Area, other than an operator access area, to which it is necessary for service personnel to have access even with the equipment switched on

3.21.1 Places that can be accessed only by maintenance personnel with special tool, lockset or keys.

3.21.2 Places with controlled access

3.22 Total harmonic distortion (THD)

Ratio in percent of the r.m.s. value of the harmonic content to the r.m.s. value of the fundamental component of the alternating quantity

3.23 Total distortion factor (TDF)

Ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the alternating quantity

3.24 Cell

Minimum time during which the UPS will ensure continuity of load power, under specified service conditions when the primary power fails, starting with the energy storage means sufficiently charged

3.25 Recell

Maximum time required to recharge sufficiently the energy storage means of the UPS with the charging capacity installed to ensure another such discharge.

NOTE – This period is the time taken after a cell discharge to restore sufficient energy to repeat the cell discharge.

3.26 Total UPS transfer time

Time interval between the occurrence of an abnormality or out-of-tolerance condition and the instant when the output quantities have been transferred

4 Plans and documents

4.1 The following plans and documents should be submitted to CCS for approval:

4.1.1 General plan and UPS deployment diagram;

4.1.2 Electrical schematic diagram;

4.1.3 Technical product conditions (For details, see Article 5 of IEC62040-3 and Annex D)

4.2 The following plans and documents should be submitted to CCS for information:

4.2.1 External wiring diagram;

4.2.2 List of specifications of supporting electric equipment and main components

4.2.3 Product installation and operation instructions.

5 Design and technical requirements

5.1 Operating conditions

The equipment should work normally under the operating conditions specified in Section 2 of Chapter 1 in Part Four of the *Rules for Classification of Sea-Going Steel Ships*. The operating conditions of the equipment are as follows, unless otherwise specified:

5.1.1 Environmental conditions

(1) Ambient air temperature: 0℃~55℃; For equipment that is required by the manufacturer to be installed in the location the ambient air temperature of which is to be controlled as per the requirement specified in 1.2.1.2 of Part Four in the *Rules for Classification of Sea-Going Steel Ships*, the max. ambient air temperature can be reduced from 55℃ to not less than 35℃, and relevant description should be added to corresponding certificate issued by CCS.

(2) Inclination and swinging: Heeling and rolling of 22.5° and trimming and pitching of 22.5°. For marine equipment used for liquefied gas and chemicals, the heeling should reach 30°. When the UPS battery inclines by 40° at all directions, measures should be taken to avoid electrolyte spillover.

(3) Vibration and shock: The general vibration condition specified in Article 2.7 of Guideline for Type Approval Test of Electrical and Electronic Products(current valid version).

(4) Damp air: Temperature of +55℃ and relative humidity of 95%.

5.1.2 Electrical operating conditions

(1) Voltage and frequency fluctuation

Voltage: Steady state change of +6~-10%, transient state change of ±20%, and recover time of 1.5 s.

Frequency: Steady state change of ±5%, transient state change of ±10%, and recover time of 5 s.

(2) Harmonic component

The AC electrical equipment should run normally when the voltage harmonic component of the power supply is not more than 5%.

5.2 Equipment enclosure and enclosure protection level

5.2.1 The equipment enclosure should be made of durable, flame-retarding and humidity-resistance materials, in which the metal part should be made of materials with sound corrosion resistance, and provided with reliable protective layer.

5.2.2 The enclosure protection level should meet relevant requirement specified in Table 1.3.2.2 of Section 3 in Chapter 1 of Part Four of the *Rules for Classification of Sea-Going Steel Ships*. For equipment installed inside the switchboard and console, the enclosure protection level should be at least IP20.

5.3 Temperature rise:

When the marine UPS operates in various working modes, the equipment temperature rise should meet the requirement in Article 7.7 of IEC62040-1.

5.4 Electrical clearance and creepage distance

The electrical clearance and creepage distance in the equipment and between components should meet the requirement in Article 5.7 of IEC62040-1.

5.5 Dielectric strength

Under normal operating conditions, the high voltage test can be carried out between different circuits of the equipment, as well as all circuits and the ground for 1 min. without any breakdown or flashover. Before test, the electronic components of each circuit can be removed.

List of voltages for high voltage test **Table 5.5**

Rated operating voltage Un (V)	**Test voltage (AC 50/60Hz)**
Less than 65	2Un + 500
66~250	1500
251~500	2000
501~690	2500

5.6 Interior wiring

The interior wiring of the equipment should meet the requirement of Article 6 of IEC62040-1.

5.7 UPS input features

The manufacturer should specify the product input features according to the requirement of Article 5.2 of IEC62040-3. The UPS should work reliably under the electrical operating conditions specified in 5.1.2 of the Guideline.

5.8 UPS output features

In any operation mode, the marine UPS should meet the requirement of the connected load on the power supply.

5.8.1 The AC output of the marine UPS should have the type-I or type-II dynamic output performance specified in Article 5.2 of IEC62040-3, and the upper limit value of the steady-state voltage should not exceed +6%. For type-II dynamic output features, the manufacturer should specify the max. dynamic voltage.

5.8.2 Generally, the marine UPS should provide sine output voltage, and the harmonic component of the AC voltage should not exceed 5% in loaded conditions. Other output waveforms should be handled separately.

5.8.3 The DC output voltage of the marine UPS should meet the following requirement at least:

Rectifier power supply: Steady-state voltage fluctuation of ±10%, cyclical voltage fluctuation of 5%, and ripple voltage of 10%.

5.9 The marine UPS should be provided with bypass operation mode.

5.10 Stored energy time and restored energy time of the marine UPS

5.10.1 Under various design loads, the stored energy time of the marine UPS should comply with the specific application.

5.10.2 The restored energy time of the marine UPS: While the UPS equipment is supplying power to the design load, the UPS charging equipment should charge the battery set to the rated capacity (or the status specified by the UPS manufacturer, which is the initial status of the battery when test during stored energy power supply) within 10 h starting from the fully discharged status of the battery set (or the discharged status of the battery set specified by the UPS manufacturer) when the main power supply is in operation.

5.10.3 For valve-regulated sealed battery set, the UPS charger should limit the charging parameters, so as to prevent the discharged flammable gas from exceeding the manufacturer's design value. Such limitation should be independent of the charging equipment or charging circuit.

5.11 Marine UPS battery

5.11.1 The battery should be manufactured according to the standard accepted by CCS, and approved by CCS. Batteries with charging power of less than 0.2 kW (the value of the nominal voltage of the battery set multiplied by max. charging current value) may be treated separately.

5.11.2 After the marine UPS passes the approval test, the battery (the manufacturer and product mode) provided should not be changed generally.

5.12 Installation and test of the marine UPS battery

5.12.1 The installation of the external UPS battery should meet relevant requirement specified in Section 11 of Chapter 2 of Part Four of the Rules for Classification of Sea-Going Steel Ships.

5.12.2 For built-in batteries, the manufacturer should submit the calculation book of ventilation quantity that is used to prevent flammable gas from gathering. The ventilation rate test should be conducted if necessary (Annex M of IEC62040-1).

5.12.3 The built-in battery should be separated physically from other electrical part, so as to avoid any adverse effect of the gas escaped from the battery on the electrical element. The gassing pressure reducing valve of the lead-acid battery should be installed upward.

5.13 Alarm and signal

The UPS device should be monitored, and proper measures should be taken to send the following audible and visual alarms to the generally-attended places:

5.13.1 Load power supply failure (voltage and frequency);

5.13.2 UPS grounding failure;

5.13.3 Operation of battery protection equipment;

5.13.4 Battery discharge;

5.13.5 Operation of online UPS bypass.

5.14 Electromagnetic compatibility

The marine UPS equipment should meet the test requirement specified in Table 3.1.2 (product category: converter) of Chapter 3 of the *Guideline on Type Approval Test of Electrical and Electronic Products* (CCS GD01-2006).

6 Type approval and unit/batch test

6.1 The marine UPS equipment should be subject to the type approval of CCS. The issuing, maintaining, modification, replacement, and cancellation of the type approval certificate should be conducted according to Chapter 3 in Part One of the *Rules for Classification of Sea-Going Steel Ships.*

6.1.1 Selection of Typical Sample

The model and specification of the test sample should be typical in technology, and cover the scope of products applied for type approval.

For products with same structure and electrical design, products with max. rated output power or max. stored energy supply time can be selected for type approval test. One set of test sample can

be selected for the specific model. The test sample should be selected by the CCS Surveyor at the factory.

6.1.2 Test agency

Test agencies accepted by CCS or the authoritative and impartial ones have the priority for type approval test. For some functional test items, the test can be conducted at the factory provided that the factory meets the test requirement and the test is approved and supervised by the CCS Surveyor.

6.1.3 Type approval test item and requirement

(1) Environmental condition test

It should be conducted according to the requirement in the *Guideline on Type Approval Test of Electrical and Electronic Products* (CCSGuideline for Type Approval Test of Electrical and Electronic Products(current valid version)). The applicable environmental condition classification (Table 1.3.2 of Guideline for Type Approval Test of Electrical and Electronic Products(current valid version)) is Class B, and the equipment type (Table 1.3.3b of Guideline for Type Approval Test of Electrical and Electronic Products(current valid version)) is "all the equipment, computers and other electronic equipment used for control, protection, safety and internal communication". The test items related to the electrical performance can be carried out together with the items specified in (2) below.

(2) Electrical performance test

For type approval test items of the marine UPS, see Table 6.1.3. In Table 1, the test items with additional requirement in the Guideline must be conducted during type approval, and for those without additional requirement, CCS can accept the test completed recently by the manufacturer based on special considerations.

(3) Special arrangement:

For each functional unit existing in the form of separate product and forming a complete UPS equipment after interconnection, separate test can be carried out on indecent functional unit to replace the type test specified in (1) after being approved by CCS. For specific test items and arrangement, see Article 6.2 and 6.7 of IEC62040-3.

List of electrical performance tests for type approval Table 6.1.3

Type approval test items for marine UPS (electrical performance)	General test requirement IEC62040-3	Additional provisions of the Guideline
1 UPS input test	6.3.2	
1) Steady-state input voltage tolerance	6.3.2.1	5.1.2
2) Input frequency tolerance	6.3.2.2	5.1.2
3) Input surge current	6.3.3	-----
2 UPS output feature: Steady state condition	6.3.4	
1) Normal operation mode: No load	6.3.4.1	5.8
2) Normal operation mode: Full load	6.3.4.2	5.8
3) Stored energy supply mode: No load	6.3.4.3	5.8
4) Stored energy supply mode: Full load	6.3.4.4	5.8
5) Output voltage unbalance test	6.3.4.5	-----
6) Output DC component	6.3.4.6	-----
3 UPS output feature: Overload and short circuit	6.3.5	-----
1) Normal operation mode: Overload	6.3.5.1	-----
2) Stored energy supply mode: Overload	6.3.5.2	-----
3) Normal operation mode: Short circuit	6.3.5.3	-----
4) Stored energy supply mode: Short circuit	6.3.5.4	-----
5) UPS rated output fault clearing capability – Normal mode	6.3.5.5	-----
6) UPS rated output fault clearing capability – Stored energy mode	6.3.5.6	-----
4 Dynamic UPS output test	6.3.6	
1) Operation mode change: Change from normal operation to stored energy supply, linear load	6.3.6. 1	5.8
2) Operation mode change: Change from stored energy supply to normal operation, linear load	6.3.6.2	5.8

Continued Table 6.1.3

Type approval test items for marine UPS (electrical performance)	**General test requirement IEC62040-3**	**Additional provisions of the Guideline**
3) Operation mode change: Change from stored energy supply to normal operation (Synchronization mode)	6.3.6.3	5.8
4) Operation mode change: Change from normal operation to bypass operation mode	6.3.6.4	5.8
5 Test of UPS dynamic load output feature	6.3.7	-----
1) UPS output load phase step - linear load	6.3.7.1	-----
6 UPS output feature - Standard nonlinear load	6.3.8	-----
1) Reference non-linear load output distortion – normal mode	6.3.8.1	-----
2) Reference non-linear load output distortion – stored energy mode	6.3.8.2	-----
3) Reference non-linear load change of operating mode	6.3.8.3	-----
4) Reference non-linear load steps – normal mode ≦4,0 kVA rating	6.3.8.4	-----
5) Reference non-linear load steps – normal mode > 4,0 kVA rating	6.3.8.5	-----
6) Reference non-linear load steps – stored energy mode	6.3.8.6	-----
7 Energy storing and restoring test	6.3.9	
1) Stored energy supply time	6.3.9. 1	5.10
2) Restored energy time	6.3. 9.2	5.10
8 Efficiency and input power factor	6.3.10	-----
9 Reverse feeding test	6.3. 11	-----
10 EMC test	6.3. 12	5.14
11 Alarm and signal	6.3.1	5.13
12 Temperature rise test	-----	5.3
13 Electrical clearance and creepage distance	-----	5.4

Continued Table 6.1.3

Type approval test items for marine UPS (electrical performance)	**General test requirement** **IEC62040-3**	**Additional provisions of the Guideline**
14 Ventilation rate test (if necessary)	-----	5.12
15 Dielectric test	-----	5.5
16 Insulation resistance measurement	-----	Article 2.3 of Guideline for Type Approval Test of Electrical and Electronic Products(current valid version)

6.2 Unit/batch Inspection

6.2.1 General requirement

After passing the type approval, the factory should conduct the following factory tests on each marine UPS equipment, and issue factory test report. The UPS with rated power of 50 kVA or higher should be inspected by the CCS Surveyor during its manufacturing and test. For other products, the Surveyor can conduct sampling inspection with sampling proportion of 10% and at least 2 sets.

The CCS Surveyor can increase the test items if necessary.

6.2.2 Factory test items

(1) Main components (parts) data verification

(2) Appearance and interior wiring inspection

(3) Insulation resistance measurement

(4) High voltage test

(5) Performance test (for specific test method and requirement, see Table 4 of IEC62040-3): light-load test, UPS auxiliary device test, synchronous test (if applicable), AC input failure test, AC input restoring test, simulation test of the parallel redundancy UPS failure (if applicable), conversion test, and full-load test.

(6) Alarm and signal test

6.2.3 CCS will issue the certificate of marine product after the product passes the factory tests specified above.