Guideline No.E-15 (202401)

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 mp@ccs.org.cn.

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Main changes and effective date:

1. Update the version of normative references;

2. Update the test items according to the latest version of normative references.

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 Normative references

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

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

2.3 IEC62040-1:2017 Uninterruptible Power Systems (UPS) – Part 1: Safety Requirements;

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

2.5 IEC 62040-5-3:2016 Uninterruptible power systems (UPS) - Part 5-3: DC output UPS - Performance and test requirements;

3 Terms and 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 CCS Rules

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 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.

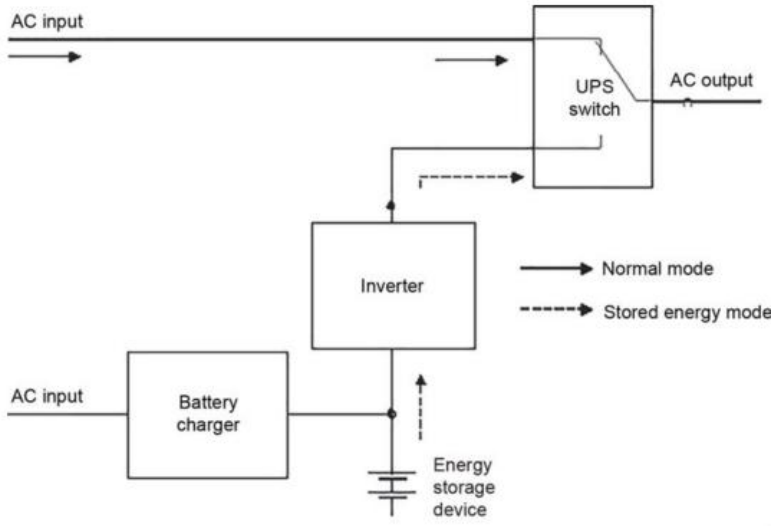

Figure 3.4 Off-line UPS unit

3.5 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.

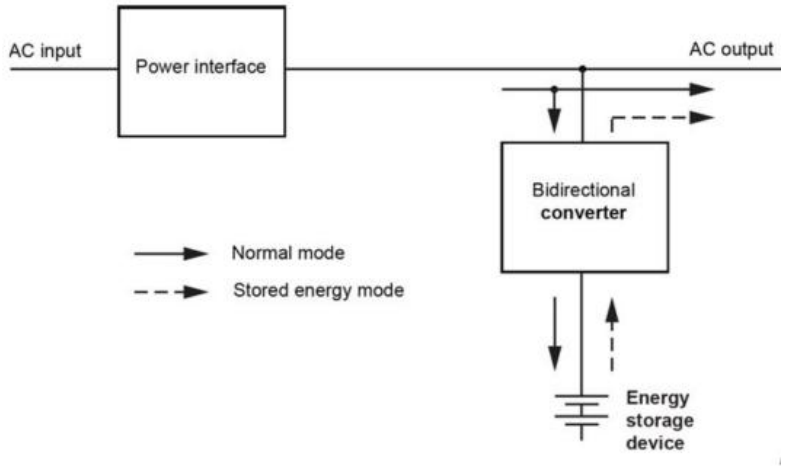

Figure 3.5 Line interactive UPS unit

3.6 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.

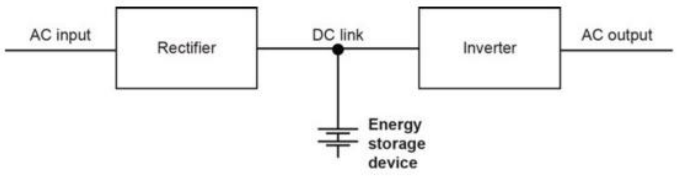

Figure 3.6 On-line UPS unit

3.7 Converter

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

3.8 energy storage device

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

3.9 DC link

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

3.10 UPS switch

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

For details, see Annex C of IEC62040-3.

3.11 Bypass

Power path alternative to the indirect a.c. converter

4 Drawings and documentation

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

(1)General plan and UPS deployment diagram;

(2) Electrical schematic diagram;

(3) Technical product conditions (For details, see Annex D of IEC62040-3);

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

(1) External wiring diagram;

(2) List of specifications of supporting electric equipment and main components

(3) Product installation and operation instructions.

5 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℃;

(2) Inclination and swinging: Heeling and rolling of 22.5° and trimming and pitching of 10°. 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).

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 8%.

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 temperature rise should meet the requirement of IEC 62477-1, chapter 4.6.4.

5.4 Design and Manufacturing

UPS units are to be constructed in accordance with IEC 62040-1:2017, IEC 62040-2:2016, IEC 62040-3:2011, IEC 62040-4:2013 and/or IEC62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard.

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 UPS input features

The manufacturer should specify the product input features according to the requirement of Article 5.2 of IEC62040-3 or Article 5.2 of IEC62040-5-3. The UPS should work reliably under the electrical operating conditions specified in 5.1.2 of the Guideline.

5.7 UPS output features

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

5.7.1 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.

5.7.2 Generally, the marine UPS should provide sine output voltage, and the harmonic component of the AC voltage should not exceed 8% in loaded conditions. Other output waveforms should be handled separately.

5.7.3 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%;

Dynamic performance of output voltage should meet the requirement Article 5.3.4 of IEC 62040-5-3, and the lower limit of the output voltage should not exceed -25%.

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

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

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

5.9.2 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.

5.9.3 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.

5.10 Marine UPS battery

5.10.1 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.

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

5.11 Installation and test of the marine UPS battery

5.11.1 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.

5.11.2 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 CC of IEC62040-1).

5.11.3 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.

5.12 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:

(1) Load power supply failure (voltage and frequency);

(2) UPS grounding failure;

(3) Operation of battery protection equipment;

(4) Battery discharge;

(5) Operation of online UPS bypass.

5.13 Electromagnetic compatibility

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

6 Materials and components

Materials and components should be controlled by the relevant requirements of CCS current rules.

7 Type test

7.1 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*.

7.1 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 maximum rated output power or maximum 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.

7.2 Test agency

Test agencies accepted by CCS or the authoritative and impartial ones have the priority for type approval test. For electrical performance tests, those tests 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.

73 Type approval test items and requirements

(1) Environmental test and EMC test

It should be conducted according to the requirement of CCS Guideline for Type Approval Test of Electrical and Electronic Products (current version). The applicable environmental condition classification (Table 1.3.2 of Guideline for Type Approval Test of Electrical and Electronic Products (current version)) is Class B, and the equipment type (Table 1.3.3b of Guideline for Type Approval Test of Electrical and Electronic Products (current 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.

EMC tests should be carried out according to Table 3.1.2 (product category: converter) of Chapter 3 of CCS Guideline for Type Approval Test of Electrical and Electronic Products (current version).

(2) Electrical performance test

For type approval test items of the marine UPS, see Table 7.3(1) or Table 7.3(2).

(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) of this chapter after being approved by CCS. For specific test items and arrangement, see Article 6.3 of IEC62040-3.

(4) Temperature rise test:

Temperature rise test should be conducted to marine UPS according to Article 4.6.4 of IEC 62040-1.

(5) Ventilation rate test:

Ventilation rate test should be conducted to marine UPS according to Article 4.102.6 of IEC 62040-1.

(6) Alarm and signal test:

Test should be conducted to marine UPS for the purpose of demonstrating that the UPS meet the requirement of Article 5.12 of this guideline.

Electrical performance test (UPS of AC output） Table 7.3（1）

No.	Test Items	IEC 62040-3	Additional requirement
1	Cable and interconnection check	6.2.2.2	-
2	Light load and functional test	6.2.2.3	-
3	No load	6.2.2.4	-
4	Full load	6.2.2.5	-
5	Synchronization	6.2.2.6	-
6	AC input power failure, VFD test	6.2.2.7	-
7	AC input power return	6.2.2.8	-
8	Transfer to bypass mode	6.2.2.9	-
9	**input—supply compatibility**		
9.1	Input voltage tolerance, VI test	6.4.1.2	5.1.2

9.2	Combined input voltage and frequency tolerance, VFI test	6.4.1.3	5.1.2
9.3	Rated input current	6.4.1.4	
9.4	Maximum input current	6.4.1.5	
9.5	Inrush current	6.4.1.6	-
9.6	Total harmonic distortion of input current	6.4.1.7	-
9.7	Input power factor	6.4.1.8	-
9.8	efficiency	6.4.1.9	-
9.9	No load losses	6.4.1.10	
9.10	Standby generator compatibility	6.4.1.11	-
10	**output—load compatibility**		
10.1	Normal mode	6.4.2.2	5.7
10.2	Stored energy mode	6.4.2.3	5.7
10.3	Unbalanced load	6.4.2.4	-
10.4	DC voltage off-set	6.4.2.5	-
10.5	Load sharing	6.4.2.6	-
10.6	Output overvoltage	6.4.2.7	-
10.7	Periodic output voltage modulation	6.4.2.8	
10.8	Overload capacity	6.4.2.9.1	
10.9	Fault clearing capacity	6.4.2.9.2	
10.10	Inverter current limit	6.4.2.9.3	
11	**Dynamic output performance**		
11.1	Normal mode to stored energy mode	6.4.2.10.2	5.7
11.2	Stored energy mode to normal mode	6.4.2.10.3	5.7
11.3	Normal mode to bypass mode –overload	6.4.2.10.4	5.8
11.4	Step load	6.4.2.10.5	-
11.5	Parallel redundant UPS failure	6.4.2.10.6	-
12	**Energy storage device**		
12.1	Stored energy time	6.4.3.1	5.9
12.2	Restored energy time	6.4.3.2	5.9
12.3	Battery ripple current	6.4.3.3	-
12.4	Restart test	6.4.3.4	-
12.5	Charger current limit	6.4.3.5	
13	**UPS functional unit tests (where not tested as a complete UPS）**		
13.1	UPS rectifier	6.6.2	
13.2	UPS inverter	6.6.3	
13.3	UPS switch	6.6.4	
13.4	Energy storage device	6.6.5	

Electrical performance test (UPS of DC output) **Table 7.3（2）**

No.	Test Items	IEC 62040-5-3	Additional requirement
1	Cable and interconnection check	6.2.2.2	-
2	Control device	6.2.2.3 a）	-
3	Protective device	6.2.2.3 b）	-
4	Auxiliary device	6.2.2.3 c）	-
5	Supervisory, monitoring, signaling device	6.2.2.3 d）	-
6	Auto transfer to stored energy mode and back to normal	6.2.2.3 e）	-
7	Manual disconnection/reconnection	6.2.2.3 f）	-
8	No load	6.2.2.4	-
9	Full load	6.2.2.5	-
10	AC input failure	6.2.2.6	-
11	AC input return	6.2.2.7	-
12	**Input supply compatibility**		
12.1	Steady-state input voltage tolerance	6.4.1.2	5.1.2
12.2	Input frequency tolerance	6.4.1.3	5.1.2
12.3	Input inrush current	6.4.1.4	-
12.4	Harmonic distortion of input current	6.4.1.5	5.1.2
12.5	Power factor	6.4.1.6	-
12.6	Efficiency	6.4.1.7	-
12.7	Stand-by power generator compatibility	6.4.1.8	-
12.8	Phase rotation test	6.4.1.9	-
13	**Output-resistive load**		
13.1	Normal mode- no load	6.4.2.1	5.7
13.2	Normal mode – full load	6.4.2.2	5.7
13.3	Stored energy mode- no load	6.4.2.3	5.7
13.4	Stored energy mode – full load	6.4.2.4	5.7
13.5	Load sharing test	6.4.2.5	-
13.6	Output overvoltage test	6.4.2.6	-
13.7	Periodic output voltage variation test (modulation)	6.4.2.7	5.7
13.8	Overload-normal mode	6.4.2.8.1	-
13.9	Overload – stored energy mode	6.4.2.8.2	-
13.10	Fault clearing capability-normal mode	6.4.2.8.3	-
13.11	Fault clearing capability – stored energy mode	6.4.2.8.4	-
13.12	Dynamic performance- normal to stored energy mode	6.4.2.9.1	5.7
13.13	Dynamic performance- stored energy to normal mode	6.4.2.9.2	5.7
13.14	Dynamic performance- step load –normal mode	6.4.2.9.3	5.7
13.15	Dynamic performance- step load-stored energy mode	6.4.2.9.4	5.7
13.16	Simulation of parallel redundant DC UPS fault	6.4.2.10	-
14	Output characteristics- constant power load	6.4.3	5.7

15	**Stored and restored energy times**		
15.1	Stored energy time	6.4.4.1	5.9
15.2	Restored energy time	6.4.4.2	5.9
15.3	Battery ripple current	6.4.4.3	-
15.4	Restart test	6.4.4.4	-

8 Unit/batch inspection

8.1 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.

Surveyor can conduct sampling inspection with sampling proportion of 10% and at least 2 sets.

8.2 Factory test items include (at least):

(1) Appearance and interior wiring inspection

(2) Performance test (for specific test method and requirement, see Table 7.3(1), 7.3(2)):

UPS of AC output: light load and functional test, no load test, full load test, synchronization, AC input failure test, AC input return test, transfer test to bypass;

UPS of DC output: control device, protective device, auxiliary device, supervisory and monitoring and signaling device, auto transfer to stored energy mode and back to normal, manual disconnection/reconnection, no load, full load, AC input failure, AC input return.

(3) Alarm and signal test;

(4) Battery capacity test (if applicable)

The CCS surveyor may add test items if necessary.