Guideline No.: E-02(201610)

# E-02 CIRCUIT-BREAKERS

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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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Main changes and effective date:

Guideline on Type Approval Test of Electrical and Electronic Products (GD01-2006) (2006)" is modified to "CCS GD 22-2015<Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version)". "GD01-2006" appearing in this guideline is modified to Guidelines for Type Approval Test of Electric and Electronic Products (current valid version). "CCS GD 22-2015 Guidelines for Type Approval Test of Electric and Electronic Products" has entered into force since Jan.1 2016.

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# CIRCUIT-BREAKERS

## 1 Application

1.1 This Guideline applies to shipborne low-voltage air circuit-breakers operated at AC 50 Hz (or 60 Hz) for rated voltages up to 1 kV (herein after called as “circuit-breakers”).

1.2 This Guideline is applicable to frame circuit-breakers and molded case circuit-breakers.

1.3 DC circuit-breakers may be referred to in this Guideline and related standards.

## 2 Utilization category

2.1 Category A (nonselective): Circuit-breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e without an intentional short-time delay provided for selectivity under short-circuit conditions. Such circuit-breakers are not required to have a short-time withstand current rating.

2.2 Category B (selective): Circuit-breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. with an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers are required to have rated short-time withstand current, characteristic of long-time, short-time and instantaneous protections as selective protection.

## 3 Normative references

3.1 The basis for approval and inspection of circuit breakers:

3.1.1CCS Rules for Classification of Sea-going Steel Ships (hereinafter referred as “Rules”);

3.1.2 IEC60947-1: 2011 Low-voltage switchgear and control gear - Part 1: General rules;

3.1.3 IEC60947-2: 2013 Low-voltage switchgear and control gear - Part 2: Circuit-breakers.

3.1.4 GD22-2015 Guidelines for Type Approval Test of Electric and Electronic Products(current valid version)

## 4 Definitions

4.1 For the purpose of this Chapter:

4.1.1 Circuit-breaker is a mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal conditions such as those of short circuit.

4.1.2 Air circuit-breaker is a circuit-breaker in which the contacts open and close in air at the atmospheric pressure.

4.1.3 Molded case circuit-breaker is a circuit-breaker having a supporting housing of molded insulating material forming an integral part of the circuit-breaker.

4.1.4Plug-in circuit-breaker is a circuit-breaker which, in addition to its interrupting contacts, has a set of contacts which enable the circuit-breaker to be removed.

4.1.5 Withdrawable circuit-breaker is a circuit-breaker which, in addition to its interrupting contacts, has a set of isolating contacts which enable the circuit-breaker to be disconnected from the main circuit, in the withdrawn position, to achieve an isolating distance in accordance with specified requirements.

4.1.6 Rated operational voltage ("Ue") is the voltage which together with rated operating current determines the purpose of a circuit-breaker, depending on appropriate test and utilization category.

4.1.7 Rated current ("In") is specified in the standard of the product, taking into account rated voltage, rated frequency, rated duty, utilization category and type of enclosure protection (if any).

4.1.8 Short-circuit breaking (or making) capacity is a breaking (or making) capacity for which the prescribed conditions include a short circuit.

4.1.9 The rated ultimate short-circuit breaking capacity ("Icu") of a circuit-breaker is the value of ultimate short-circuit breaking capacity (see 2.15.1) assigned to that circuit-breaker by the manufacturer for the corresponding rated operational voltage, under the specified conditions. It is expressed as the value of the prospective breaking current, in kA (r.m.s. value of the a.c. component in the case of a.c.).

4.1.10 The rated service short-circuit breaking capacity ("Ics") of a circuit-breaker is the value of service short-circuit breaking capacity assigned to that circuit-breaker by the manufacturer for the corresponding rated operational voltage, under the specified conditions. It is expressed as a value of prospective breaking current, in kA, corresponding to one of the specified percentages of the rated ultimate short-circuit breaking capacity and rounded up to the nearest whole number. It may be expressed as a % of *I*cu (for example *I*cs = 25 % *I*cu).

4.1.11 Rated short-time withstand current ("Icw") is the current that a circuit or a circuit-breaker in the closed position can carry during a specified short time under prescribed conditions of use and behavior (the minimum rated short-time withstand current is specified in IEC 600947-2).

4.1.12 Verification and verification test: The term "verification" referred to in this Chapter is to be interpreted as "test for the verification" and has been used where it is intended to verify the condition of the circuit-breaker following an earlier test in a test sequence whereby it may have

been adversely affected. Satisfactory verification of a test item means completion of the item.

## 5 Plans and documents

5.1 The following plans and documents are to be submitted to CCS for approval:

5.1.1 Drawing of general assembly;

5.1.2 Electrical schematic diagram;

5.1.3 Drawings of electrical wiring;

5.1.4 Technical specifications;

5.1.5 Type test programme.

5.2 The following plans and documents are to be submitted to CCS for information:

5.2.1 Nameplates and marks;

5.2.2 Detailed list of main components and parts and materials;

5.2.3 Drawing of main components and parts (including contacts, arc-quenching chamber and operated mechanism etc.);

5.2.4 Operation instructions for the products;

5.2.5 Production process flow chart.

5.3 Other documents to be submitted:

5.3.1 particulars of the manufacturer, including the name, address, history, production capacity, technical and inspection personnel, main products, subordinate relationship, trademark, etc.;

5.3.2 Details of the products for approval;

5.3.3 Main production equipment;

5.3.4 Main test equipment;

5.3.5 Brief production technology of the products for approval;

5.3.6 Quality management documents;

5.3.7 Document of entering to the register of enterprise;

5.3.8 Qualification certificate and/or production license;

5.3.9 Specimen of products quality certificate;

5.3.10 Quality control scheme (where applicable).

**6 Selection of typical samples**

6.1 Each test sequence is to be carried out on one (or one group of) new and clean circuit-breaker(s).

6.2 The number and test conditions of samples for each test sequence are listed according to parameters of the circuit-breaker in Table 6.2.

**Number of Samples for Test** **Table 6.2**

| Test sequence | Terminals marked line/load | | Sample quantity | Sample no. | Current setting ① | | Test voltage | Test current | | Verification of temperature rise | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | No | | | Min. | Max. | | Corresponding | Max. | | |
| I | × | × | 1 | 1 | | × | Max. Ue | × | | × | ⑧，⑨，⑩ |
| II (Ics) and combined | × | | 2 | 1<br>2 | × | × | Ue<br>Ue | ×<br>× | | × | ⑧，⑨，⑩，② |
| | | × | 3 | 1<br>2<br>3 | × | ×<br><br>× | Ue<br>Ue<br>Ue | ×<br>×<br>× | | ×<br><br>× | ⑧，⑨，⑩，②<br>③，⑩ |
| III (Icu) | × | | 2 | 1<br>2 | × | × | Ue<br>Ue | ×<br>× | | | ⑧，⑨，⑩，②，④ |
| | × | × | 3 | 1<br>2<br>3 | × | ×<br><br>× | Ue<br>Ue<br>Ue | ×<br>×<br>× | | | ⑧，②，③ |
| IV (Icw) | As for test sequence III | | | | | | | | | | ⑤ |

Notes:

① Min means the minimum In of a given frame size;. in the case of adjustable overload releases,

it means the minimum setting of the minimum In. Max. means the maximum In of a given frame size.

② For a circuit-breaker having a single non-adjustable current setting for a given frame size and for a circuit-breaker provided only with a shunt release (i.e. without an integral overcurrent release), the sample is omitted.

③ Connections reversed.

④ Connections revered wiring, if terminals unmarked.

⑤ Applicable to Category A and Category B circuit-breakers.

⑥ To be agreed between test station and manufacturer.

⑦ For terminals unmarked, an additional sample is to be tested with connections reversed.

⑧ In the case of one or more construction breaks within the frame size, a further sample is tested at the maximum rated current corresponding to each construction, under the conditions applicable to sample 1.

⑨ The requirements of note 8) apply to the combined test sequence only.

⑩ For circuit-breakers where the value In differs through external current-carrying parts (i.e. interchangeable terminals or draw-out cradle connections), the minimum and maximum ratings of this construction is to be subjected to the full sequence. At the end of the sequence, the maximum rating sample is then to be adapted to perform a verification of temperature rise on each variation of external current-carrying parts.

**7 Design and technical requirements**

7.1 Operating conditions of shipboard circuit-breakers are to comply with the requirements in Section 2, Chapter 1, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

7.2 Design and construction of shipboard circuit-breakers (including air clearance and creepage distance, insulating materials, conducting materials, earthing and protective enclosure, etc.) are to comply with IEC publication 60947-2 and Section 3, Chapter 1, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

7.2.1 Shipboard circuit-breakers are to be trip-free fitted with anti-jump control device so that they can be freely released at any position during switching-on. Each circuit-breaker is to be so arranged that it will not close the circuit by any inadvertent movement at the OFF position.

7.2.2 The frame, skeleton and fixed components of the metallic enclosure of shipboard frame circuit-breakers are to be electrically connected to each other, to earthed terminals and reliably earthed.

7.3 Technical and performance requirements

7.3.1 Protective properties of circuit-breakers are to comply with the requirements in Section 5, Chapter 2, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

7.3.2Power-operated closing is to comply with the following requirements:

(1) The power-operated closing mechanism is to be capable of securing the closing of the circuit-breaker in any condition between no-load and its rated making capacity, when the supply voltage, measured during the closing operation, remains between 85% and 110% of the rated control supply;

(2) At 110% of the rated control supply voltage, the closing operation performed on no-load is not to cause any damage to the circuit-breaker.

7.3.3 Stored energy closing is to comply with the following requirements:

(1) When the stored energy is retained within the circuit-breaker, a device must be provided which indicates when the storing mechanism is fully charged;

(2) Means for charging the operating mechanism are to be capable of operating when the auxiliary supply voltage is between 85% and 110% of the rated control supply voltage;

(3) When the energy storing mechanism is manually operated, the direction of operation is to be indicated.

7.3.4 Opening is to comply with the following requirements:

(1) Circuit-breakers which open automatically are to be trip-free (i.e. capable of being released automatically at any operating position);

(2) A shunt release for opening is to cause tripping under all operation conditions of the circuit-breaker when the supply voltage of the shunt release measured during the tripping operation remains between 70% and 110% of the rated control supply voltage;

(3) Opening by under-voltage releases:

①Performance not related to frequency

The operating performance of an under-voltage release is to remain effective in case of substantial reduction of power supply frequency and release the circuit-breaker easily;

②Operating voltage

An under-voltage release is to operate a delayed or instantaneous opening of the circuit-breaker on a falling supply voltage within the range between 70% and 35% of the rated voltage. The under-voltage release is to prevent the closing of the circuit-breaker when

the supply voltage is below 35% of the rated voltage of the release, and it is to permit the closing of the circuit-breaker at supply voltages equal to or above 85% of its rated value.. Unless otherwise stated in the relevant product standard, the upper limit of the supply voltage is to be 110% of its rated value.

7.3.5 Circuit-breakers should reserves well the energy required to the tripping operation before the closing operation.

7.3.6 Circuit breaker should be fitted with dependent manual closing mechanism in accordance with IEC60947-2 para. 7.2.1.

## 8 Type test

8.1 Type tests are grouped in a number of sequences and one circuit-breaker is to be used for each sequence.

8.2 The items, technical requirements and test methods for test sequences are given in Table 8.2.

**Summary of Type Test** **Table 8.2**

| No. | Test item | Technical requirement | Test method |
|---|---|---|---|
| 1 | Construction examination | IEC 60947-2 para. 8.2 | IEC 60947-2 para. 8.2 |
| 2 | Dielectric test | IEC 60947-2 para. 8.4.5 | IEC 60947-2 para. 8.4.5 |
| 3 | Tripping limits and characteristics | IEC 60947-2 para. 7.2.1.2.4 | IEC60947-2 para. 8.3.3.1 |
| 4 | Mechanical operation and operational performance capability | IEC 60947-2 7.2.4.2, Table 8 | IEC 60947-2 para.8.3.3.3 |
| 5 | Overload performance (if applicable) | IEC 60947-2 para. 7.2.4.1 | IEC 60947-2 para. 8.3.3.4 |
| 6 | Rated service short-circuit breaking capacity | IEC 60947-2 para. 8.3.4.1 | IEC 60947-2 para. 8.3.4.1 |

**Continued table 8.2**

| No. | Test item | Technical requirement | Test method |
|---|---|---|---|
| 7 | Rated ultimate short-circuit breaking capacity | IEC 60947-2 para. 8.3.5.2 | IEC 60947-2 para., 8.3.5.2 |
| 8 | Rated short-time withstand current | IEC 60947-2 para. 8.3.6.2 | IEC 60947-2 para. 8.3.6.2 |
| 9 | Combined sequence test:<br>Rated short-time withstand current | IEC 60947-2 para. 8.3.8.2 | IEC 60947-2 para. 8.3.8.2 |
| 10 | Combined sequence test:<br>Rated service short-circuit breaking (delay) capacity | IEC 60947-2 para. 8.3.8.3 | IEC 60947-2 para. 8.3.8.3 |
| 11 | Test sequence for circuit-breakers for IT systems | IEC 60947-2 Annex H | IEC 60947-2 Annex H |
| 12 | Damp heat test (55℃) | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.10 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.10 |
| 13 | Tripping limits and characteristics in inclination conditions | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.6 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.6 |

**Continued table 8.2**

| No. | Test item | Technical requirement | Test method |
|---|---|---|---|
| 14 | Vibration test | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.7 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.7 |
| 15 | Flame-retardant test* | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.16 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.16 |
| 16 | Power supply variation test | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.4 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), 2.4 |
| 17 | Electromagnetic compatibility test | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), Chapter 3 | CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (CURRENT VALID VERSION), Chapter 3 |

* The test item may be omitted if the manufacturer of plastic materials can prove the compliance with the requirements of CCS GUIDELINE ON TYPE APPROVAL TEST OF ELECTRICAL AND ELECTRONIC PRODUCTS (current valid version).

## 9 Unit/batch inspection

9.1 According to the CCS Rules, this product does not need an inspection after approval, for inspection, see 9.2.

9.2 The inspection is to include:

9.2.1 General examination and construction examination (IEC 60947-2, 8.2);

9.2.2 Examination of operating characteristics (IEC 60947-2, 8.4.1 and 8.4.3);

9.2.3 Characteristics of over-current release (IEC 60947-2, 8.4.2), (as per the delivery order or technical documents);

9.2.4 Dielectric test (IEC 60947-2, 8.4.5).