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Safety of machinery - Specification for emergency stop devices

机械安全 急停装置技术条件

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Safety of machinery - Specification for emergency stop devices

1 Scope

This document specifies the technical requirements, tests, and information for use, etc. of emergency stop devices that realize emergency stop function.

This document applies to emergency stop devices that trigger the emergency stop function by pressing a button.

2 Normative references

The contents of the following documents, through normative references in this text, constitute indispensable provisions of this document. Among them, for dated references, only the edition corresponding to that date applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 2423.7 Environmental testing - Part 2: Test methods - Test Ec: Rough handling shocks, primarily for equipment-type specimens

GB/T 2423.22 Environmental testing - Part 2: Test methods - Test N: Change of temperature

GB/T 4208-2017 Degrees of protection provided by enclosure (IP code)

GB/T 14048.1-2012 Low-voltage switchgear and controlgear - Part 1: General rules

GB/T 14048.5-2017 Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching element - Electromechanical control circuit devices

GB/T 14048.14-2019 Low-voltage switchgear and controlgear - Part 5-5: Control circuit devices and switching elements - Electrical emergency stop device with mechanical latching function

GB/T 15706-2012 Safety of machinery - General principles for design - Risk assessment and risk reduction

GB/T 16754-2021 Safety of machinery - Emergency stop function - Principles for design

3 Terms and definitions

The terms and definitions defined in GB/T 15706-2012 and GB/T 16754-2021 and the following ones apply to this document.

3.1

Emergency stop

Emergency stop function

A function triggered by a single person action to prevent an ongoing or reduce an existing danger to personnel, damage to machinery or work in progress.

[Source: GB/T 15706-2012, 3.40, modified]

3.2

Emergency stop device

The control device for artificially triggering the emergency stop function.

[Source: GB/T 16754-2021, 3.3]

3.3

Mean cycles to dangerous failure

B_{10D}

The average number of cycles until 10% of the elements fail dangerously.

Note: The element can be a mechanical element, an electromechanical element, a pneumatic element, or a hydraulic element.

3.4

Direct opening

The specified action of contact unit in which the contact separation is directly realized by an inelastic part (e.g., no spring is used).

[Source: GB/T 14048.5-2017, K.2.2, modified]

3.5

Force of direct opening

4.3.6 Prevent accidental triggering

To prevent accidental triggering, a protective ring can be added. The structure of the protective ring shall not cause damage to the hand that triggers the emergency stop function; nor shall it weaken the triggering ability of emergency stop function.

4.4 Environmental adaptability

The parts, devices, and elements of emergency stop device shall be selected, assembled, connected and guarded so that they can operate correctly under the expected operating conditions and environmental influences.

The emergency stop device shall be able to work normally under the following conditions:

- Temperature: -10 ℃~55 ℃;
- When the maximum temperature is 40 °C, the relative humidity of air does not exceed 50%. A higher relative humidity can be allowed at lower temperatures, such as 90% at 20 °C. Special measures shall be taken for occasional condensation due to temperature changes.

4.5 Mechanical properties

During the intended use, the emergency stop device shall have sufficient anti-vibration, anti-shock and anti-drop properties, to prevent the loss of safety functions due to vibration, shock and drop.

4.6 Electrical properties

4.6.1 Withstand voltage

After the emergency stop device is subjected to the withstand voltage test according to 8.3.3.4 in GB/T 14048.1-2012, there shall be no breakdown and no arcing.

4.6.2 Clearance and creepage distance

Pollution degree 3.

The minimum value of clearance and creepage distance shall meet the requirements given in Table 13 and Table 15 in GB/T 14048.1-2012.

4.6.3 Degree of protection provided by enclosure

The degree of protection provided by enclosure of emergency stop device shall be at least IP65.

5 Tests

5.1 Test for structural requirements

Check the electrical symbol identification and structural schematic diagram. The structure shall meet the requirements of 4.2.

5.2 Test for safety requirements

5.2.1 Force and stroke of direct opening

Apply force along the axial direction of the button, until the contact of emergency stop device is disconnected. Record the force value at this time (force of direct opening) and the displacement of the button (stroke of direct opening). Continue to apply force, to verify whether the further displacement of the button is not less than 0.5 mm.

The force of direct opening shall meet the requirements of 4.3.1.

5.2.2 Mean cycles to dangerous failure (B_{10D})

Randomly select no less than 10 test objects. According to the requirements of Appendix C in GB/T 14048.5-2017, do the durability test, until 10% of the test objects fail. The number of cycles at this time is B_{10}. The calculation of B_{10} value is shown in Appendix A.

The B_{10D} value can be determined in the following ways:

a) Assume the rate of dangerous failure is 50%. Then the B_{10} value can be doubled to get the B_{10D} value: $B_{10D}=2B_{10}$;

b) By analyzing objects that fail the test and determining the percentage of potentially dangerous failure, determine the B_{10D} value.

The B_{10D} value shall meet the requirements of 4.3.2.

5.2.3 Mechanical latching function

Test and verify in accordance with 7.5, 7.6, 7.7 in GB/T 14048.14-2019. The mechanical latching function shall meet the requirements of 4.3.3.

5.2.4 Contact unit

According to 7.5 and 7.6 in GB/T 14048.14-2019, carry out the shock test and vibration test, respectively.

Visually observe whether the contact unit comes off.

The testing device shall be able to detect any opening or closing of contact greater than 0.2 ms.

5.4.2 Shock test

The emergency stop device shall be tested in the static position; shall bear 15 g shock in both directions of the corresponding axis for a duration of 11 ms.

During the test, closed contacts shall not be opened; open contacts (if applicable) shall not be closed. The latching mechanism shall not be locked.

The testing device shall be able to detect any opening or closing of contact greater than 0.2 ms.

5.4.3 Drop test

After the emergency stop device is subjected to a drop test with a height of 1 m according to GB/T 2423.7, the function shall meet the requirements of 4.5.

5.5 Test for electrical properties

5.5.1 Withstand voltage test

The withstand voltage test is carried out according to 8.3.3.4 in GB/T 14048.1-2012. The voltage value (effective value of alternating current) of power-frequency withstand voltage test is 1890 V; the time is 1 s.

Withstand voltage test conditions between the same-pole terminals of emergency stop device: AC2500 V, 50/60 Hz, 1 min.

Withstand voltage test conditions between each terminal and the ground: AC2500 V, 50/60 Hz, 1 min.

The test shall have no breakdown and no arcing.

5.5.2 Clearance and creepage distance

The test of clearance and creepage distance shall be carried out in accordance with the provisions of Appendix G of GB/T 14048.1-2012. The test results shall meet the requirements of 4.6.2.

5.5.3 Degree of protection provided by enclosure

The test of degree of protection provided by enclosure shall be carried out in accordance with the provisions of 13.4 and 14.2.5 of GB/T 4208-2017. After the test, there shall be no obvious dust deposition in the enclosure. The waterproof shall meet the requirements of 14.3 of GB/T 4208-2017.

6 Information for use

6.1 General requirements

The information provided to the user and its presentation method shall meet the requirements of 6.4 in GB/T 15706-2012.

6.2 Enclosure identification

The emergency stop device shall be permanently and clearly marked. The character height shall not be less than 2 mm.

On the enclosure (or outer packaging) of emergency stop device, at least the following information shall be given by identification:

- Manufacturer’s name or trademark;

- Product name;

- Model;

- Production date;

- Symbol for direct opening, " ";

- IP degree of protection;

- Electrical parameters;

- Number of standard executed.

6.3 Instructions for use

Instructions for use shall include at least the following:

a) Manufacturer's name and full address;

b) Product name and model;

c) Schematic diagram of structure principle;

d) General description of emergency stop device and its application;

e) Instructions for assembly, installation, and connection of emergency stop device;

f) B_{10D};

g) Electrical parameters (rated voltage, current, etc.);

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