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JAPANESE INDUSTRIAL STANDARD

Fire Hazard Testing Part 2: Test Methods Bad-Connection Test with Heaters

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Fire Hazard Testing
Part 2: Test Methods
Bad-Connection Test with Heaters

C 60695-2-3:1987

1. Introduction and Scope

This Japanese Industrial Standard specifies a method for bad-connection test with heaters as selected from among the test methods for examining the fire resistance of electric/electronic products, subassemblies and components.

The best method for testing electric/electronic products with regard to fire hazard is to duplicate exactly the conditions occurring in practice. In most instances this is not possible. Accordingly, for practical reasons, the testing of electric/electronic products with regard to fire hazard is best conducted by simulating as closely as possible the actual effects occurring in practice.

Parts of electric/electronic equipment which might be exposed to excessive thermal stress due to electric effects and the deterioration of which might impair the safety of the equipment shall not be unduly affected by heat and by fire generated within the equipment.

Connections may produce, under certain conditions, for example, loosening, insufficient mechanical pressure or faulty installation, high heat dissipation due to wattage losses depending on their design and the actual current passing through them.

Reference: This Standard is a translated version of IEC 695-2-3 (1984) Fire Hazard Testing, Part 2: Test Methods, Bad-Connection Test with Heaters. Part of it, however, has been modified to correspond to the actual circumstances in Japan.

Applicable Standards:

JIS C 1102-Electrical Indicating Instruments

JIS C 2303-Insulated Tissue Papers

JIS C 2520-Wires and Rolled Wires for Electrical Heating

JIS P 3901-Carbonizing Paper

Corresponding International Standard:

IEC 695-2-3 Fire hazard testing, Part 2: Test methods, Bad-connection test with heaters

Reference Standards:

JIS C 0060-Fire Hazard Testing. Part 2: Test Methods, Glow-wire Test and Guidance

JIS C 0061-Fire Hazard Testing. Part 2: test Methods, Needle Flame Test

JIS S 3104-Facial Tissues

2. Object of Test

Connections may, under certain conditions, be a source of heat such that, after a long period, parts of insulating material retaining these connections in position are likely to be unduly affected.

Bad connection denotes a fault condition in a terminal which may give rise to the production of abnormal heat. The bad-connection test with heaters is a test intended to simulate such an overheated connection, consideration being given to the design of the connection and to the current passing through it under normal conditions of use, in order to assess the fire hazard.

The test is only intended to be applied to screw connections which the user or service man is required to make during the installation, servicing or maintenance of the equipment and which are therefore outside the manufacturer's control. The test is applicable to screw connections having a rated current not exceeding 63 A.

Reference: JIS C 0060 [Fire Hazard Testing (Electric/Electronic) Glow-wire (Glow Rod Pressing) Test] or JIS C 0061 [Fire Hazard Testing (Electric/Electronic) Needle-flame (Injection Needle Burner) Test] may be applied to the fire resistance test for the insulation of connections of types other than screw clamping.

3. General Description of Test

If possible the specimen should be a complete equipment, subassembly or component. If it is necessary to perform the test within the product, part of an enclosure may be taken away or part which may be an obstacle to the test may be cut off, in which case care should be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation, thermal stresses and possible flames occurring or burning or glowing particles falling in the vicinity of the specimen.

If it is not possible to make the test on a subassembly or component within the product, the test is made on a separate specimen under the conditions specified in Clause 4.

The test is applied to ensure:

- (1) that a connection, heated under defined conditions by means of an appropriate test heater, does not cause ignition of parts of insulating material, or
- (2) that a part of insulating material, which might be ignited by the overheated connection under defined conditions, has a limited duration of burning, without spreading fire by flames, burning droplets or glowing particles falling from the specimen.

If the specimen is ignited by this method, the fire hazard created may necessitate further tests using other sources of ignition such as the needle-flame.

Remark: The test heaters specified in Clause 4 may not be appropriate for testing terminals other than those with screw-clamping. Their usability has only been verified for designs and sizes of terminals with screw-clamping as described in Appendix A.

4. Description of Test Apparatus

The resistance wire of the test heater consists of a piece of wire of Class 2 nickel-chromium alloy specified in JIS C 2520 (containing at least 57 % nickel, 15 to 18 % chromium, 0.15 % or less carbon, 0.75 to 1.6 % silicon, 1.5 % or less manganese, and the remainder iron, its volume resistivity at a temperature of 23°C being 1.12 $\mu\Omega\text{m}$). Each end of this resistance wire is connected, by means of a copper alloy sleeve, to a lead of circular cross section, composed of fine-wire copper strands and having a length of 120 ± 2 mm (see Fig. 1 of Appendix A).

Reference: IEC 695-2-3 specifies that the material of the resistance wire has a specific resistance at a temperature of 20°C of 1.13 $\Omega\text{mm}^2/\text{m}$ and contains at least 59 % nickel, 14 to 19 % chromium, and 19 to 23 % iron.

The shape, the diameter and the length of the resistance wire shall be adapted to the design and the size of the terminal to which the conductor is to be connected, taking into account the test power specified in the table.

In order to avoid overheating and melting of the test heater, a specific surface load, related to the diameter and the length of the resistance wire specified above shall not be exceeded. The actual value " n " of the specific surface load can be calculated from the following formula and shall be compared with the maximum value " n_{max} " for determining the minimum permitted dimensions of the resistance wire.

$$n = \frac{N}{\pi \cdot d_h \cdot l_h}$$

where n : specific surface load (W/mm^2)

N : test power (W)

d_h : diameter of the resistance wire (mm)

l_h : free length of the resistance wire (mm)

If $d_h \geq 1.0$ mm, n_{max} to 0.36 W/mm^2 , and if $d_h = 0.5$ mm, n_{max} to 0.40 W/mm^2 .

The diameter of the leads to be connected to the resistance wire and that of the sleeves shall be chosen on the basis of the heat dissipation caused in the terminals connected to the wire under normal conditions of use.

In order to insulate the resistance wire by oxidizing its surface it is necessary to heat the test heater electrically to red hot under normal atmospheric conditions.

For the purpose of subsequent checking of the test heater so as to detect any deterioration, the resistance is measured between the "cold" ends (see 4.2 of Appendix A) of the leads when new, and is noted.

Remark: Guidance for preparing the test heaters adapted to the sizes and designs of terminals with screw clamping is given in Appendix A.

An adjustable extra-low voltage transformer is used to energize the test heater so as to obtain the test power specified.

The voltmeter and ammeter for measuring the voltage drop across the test heater and the current passing through it should be accurate to 1 % [i.e. Class 0.5 according to JIS C 1102 (Indicating Electrical Measuring)]. If a wattmeter is used, its accuracy shall be 1.5 % or better.

To evaluate the possibility of spread of fire, for example, by burning or glowing particles falling from the specimen, one of the following situations need to be specified in the relevant specification:

- (1) If the specimen is tested within the product and if the environment in which the product is to be used is known, a layer of the material or components normally surrounding or situated underneath the product shall be arranged.
- (2) If the specimen is tested within the product and if the environment in which the product is to be used is unknown, a piece of wooden board ⁽²⁾, approximately 10 mm thick and covered with a single layer of tissue paper ⁽¹⁾, shall be arranged at a distance of 200 ± 5 mm below the specimen unless otherwise specified in the relevant specification.
- (3) If the specimen is tested separately, it is mounted on a piece of wooden board ⁽²⁾ approximately 10 mm thick. Before starting the test, the board is conditioned for seven days (168 h) in an atmosphere having a temperature of $23 \pm 2^\circ\text{C}$ and a relative humidity of 50 ± 5 %.

Note ⁽¹⁾ Tissue paper Equivalent to the Class 3 carbonizing paper as specified in JIS P 3901 (Carbonizing Paper) or to the tissue paper specified in JIS C 2303 (Insulated Tissue Paper)

Reference: Wrapping tissue as specified in 6.86 of ISO Standard 4046 (1978) (paper, paper board, pulp, and other similar types of paper - terms). A soft and strong, lightweight wrapping paper of grammage generally between 12 g/m² and 30 g/m², primarily intended for protective packaging of delicate articles and for gift wrapping, not a paper specified in JIS S 3104 (Tissue Paper) which is generally in use in Japan.

Note ⁽²⁾ Wooden board Pinus strobus, abies sachalinensis, or cryptomeria japonica. In the case of cryptomeria japonica, sapwood (white portion).

Reference: IEC 695-2-3 specifies white pine, which is called "pinus strobus" in Japan. As it is difficult to obtain, this Standard permits the use of abies sachalinensis or cryptomeria japonica.