4.6.5 Adhesives for constructional purposes

If a barrier or screen provided to comply with 4.6.1, 4.6.2 or 4.6.4 is secured with adhesive to the inside of the ENCLOSURE or to other parts inside the ENCLOSURE, the adhesive shall have adequate bonding properties throughout the life of the equipment.

Compliance is checked by examination of the construction and of the available data. If such data is not available, compliance is checked by the following tests.

A sample of the equipment or a part of the ENCLOSURE with the barrier or screen attached is evaluated with the sample placed with the barrier or screen on the underside.

Condition the sample in an oven at one of the following temperatures for the time durations specified:

100 °C ± 2 °C for one week; or

90 °C ± 2 °C for three weeks; or

82 °C ± 2 °C for eight weeks.

Upon completion of the temperature conditioning, subject the sample to the following:

– *remove the sample from oven and leave it at any convenient temperature between 20 °C and 30 °C for 1 h;*

– *place the sample in a freezer at -40 °C ± 2 °C for 4 h;*

– *remove and allow the sample to come to any convenient temperature between 20 °C and 30 °C for 8 h;*

– *place the sample in a cabinet at 91 % to 95 % relative humidity for 72 h;*

– *remove the sample and leave it at any convenient temperature between 20 °C and 30 °C for 1 h;*

– *place the sample in an oven at the temperature used for the temperature conditioning for 4 h;*

– *remove the sample and allow it to reach any convenient temperature between 20 °C; and 30 °C for 8 h.*

The sample is then immediately subjected to the tests of 4.2 as applicable. The barrier or screen shall not fall off or partly dislodge as a result of these tests.

With the concurrence of the manufacturer, it is permitted to increase any of the above time durations.

4.7 Resistance to fire

This subclause specifies requirements intended to reduce the risk of ignition and the spread of flame, both within the equipment and to the outside, by the appropriate use of materials and components and by suitable construction.

NOTE 1 The risk of ignition is reduced by limiting the maximum temperature of components under normal operating conditions and after a single fault (see 1.4.14), or by limiting the power available in a circuit.

NOTE 2 The spread of flame in the event of ignition is reduced by the use of flame retardant materials and insulation, or by providing adequate separation.

NOTE 3 For a ranking of materials with respect to flammability, refer to the notes in 1.2.12.1.

〖C〗 *Note deleted* 〖C〗

Metals, ceramic materials and glass shall be considered to comply without test.

4.7.1 Reducing the risk of ignition and spread of flame

For equipment or a portion of equipment, there are two alternative methods of providing protection against ignition and spread of flame that could affect materials, wiring, wound components and electronic components such as integrated circuits, transistors, thyristors, diodes, resistors and capacitors.

Method 1 – Selection and application of components, wiring and materials that reduce the possibility of ignition and spread of flame and, where necessary, by the use of a FIRE ENCLOSURE. The appropriate requirements are detailed in 4.7.2 and 4.7.3. In addition, the simulated faults of 5.3.7 are applied, except for 5.3.7 c), when using this method.

NOTE 1 Method 1 may be preferred for equipment or that portion of equipment with a large number of electronic components.

Method 2 – Application of all of the simulated fault tests in 5.3.7. A FIRE ENCLOSURE is not required for equipment or that portion of equipment for which only Method 2 is used. In particular, 5.3.7 c) applies, which includes testing all relevant components in both PRIMARY CIRCUITS and SECONDARY CIRCUITS.

NOTE 2 Method 2 may be preferred for equipment or that portion of equipment with a small number of electronic components.

4.7.2 Conditions for a fire enclosure

A FIRE ENCLOSURE is required when temperatures of parts under fault conditions could be sufficient for ignition.

4.7.2.1 Parts requiring a fire enclosure

Except where Method 2 of 4.7.1 is used, or as permitted in 4.7.2.2, the following are considered to have a risk of ignition and, therefore, require a FIRE ENCLOSURE:

– components in PRIMARY CIRCUITS;

– components in SECONDARY CIRCUITS supplied by power sources that exceed the limits specified in 2.5;

– components in SECONDARY CIRCUITS supplied by limited power sources as specified in 2.5, but not mounted on V-1 CLASS MATERIAL;

– components within a power supply unit or assembly having a limited power output as specified in 2.5, including overcurrent protective devices, limiting impedances, regulating networks and wiring, up to the point where the limited power source output criteria are met;

– components having unenclosed arcing parts, such as open switch and relay contacts and commutators, in a circuit at HAZARDOUS VOLTAGE or at a HAZARDOUS ENERGY LEVEL; and

– insulated wiring.

4.7.2.2 Parts not requiring a fire enclosure

The following do not require a FIRE ENCLOSURE:

– motors;

– transformers;

– electromechanical components complying with 5.3.5;

– wiring and cables insulated with PVC, TFE, PTFE, FEP, polychloroprene or polyimide;

– plugs and connectors forming part of a power supply cord or INTERCONNECTING CABLE;

– components, including connectors, meeting the requirements of 4.7.3.2, which fill an opening in a FIRE ENCLOSURE;

– connectors in SECONDARY CIRCUITS supplied by power sources that are limited to a maximum of 15 VA (see 1.4.11) under normal operating conditions and after a single fault in the equipment (see 1.4.14);

– connectors in SECONDARY CIRCUITS supplied by limited power sources complying with 2.5;

– other components in SECONDARY CIRCUITS:

  • supplied by limited power sources complying with 2.5 and mounted on V-1 CLASS MATERIAL;

  • supplied by internal or external power sources that are limited to a maximum of 15 VA (see 1.4.11) under normal operating conditions and after a single fault in the equipment (see 1.4.14) and mounted on HB75 CLASS MATERIA,L if the thinnest significant thickness of this material is < 3 mm, or HB40 CLASS MATERIAL, if the thinnest significant thickness of this material is ≥ 3 mm;

〖C〉 *Note deleted* 〈C〗

  • complying with Method 2 of 4.7.1;

– equipment, or a part of the equipment, having a momentary contact switch that the USER has to activate continuously, and the release of which removes all power from the equipment or part.

Compliance with 4.7.2.1 and 4.7.2.2 is checked by inspection and by evaluation of the data provided by the manufacturer. In the case where no data is provided, compliance is determined by tests.

4.7.3 Materials

4.7.3.1 General

ENCLOSURES, components and other parts shall be so constructed, or shall make use of such materials, that the propagation of fire is limited.

VTM-0 CLASS MATERIAL, VTM-1 CLASS MATERIAL and VTM-2 CLASS MATERIAL are considered to be equivalent to V-0 CLASS MATERIAL, V-1 CLASS MATERIAL and V-2 CLASS MATERIAL, respectively, for their flammability properties. Their electrical and mechanical properties are not necessarily equivalent.

Where HB40 CLASS MATERIAL, HB75 CLASS MATERIAL or HBF CLASS FOAMED MATERIAL, is required, material passing the glow-wire test at 550 °C according to IEC 60695-2-11 is acceptable as an alternative.

Where it is not practical to protect components against overheating under fault conditions, the components shall be mounted on V-1 CLASS MATERIAL. Additionally, such components shall be separated from material of a class lower than V-1 CLASS MATERIAL (see 1.2.12.1, Note 2) by at least 13 mm of air, or by a solid barrier of V-1 CLASS MATERIAL.

NOTE 1 See also 4.7.3.5.

〖C〉 *Note deleted* 〈C〗

NOTE 3 In considering how to limit propagation of fire, and what are "small parts", account should be taken of the cumulative effect of small parts when they are adjacent to each other, and also of the possible effect of propagating fire from one part to another.

NOTE 4 The material flammability requirements in 4.7.3 are summarized in Table 4E.

Compliance is checked by inspection and by evaluation of relevant data provided by the manufacturer.

4.7.3.2 Materials for fire enclosures

The following requirements apply as appropriate.

The 18 kg mass criterion applies to individual complete equipments, even if they are used in close proximity to each other (for example, one on top of another). However, if a part of the FIRE ENCLOSURE is removed in such a situation (in the same example, the bottom cover of the top equipment), the combined mass of the equipment applies. In determining the total mass of equipment, supplies, consumable materials, media and recording materials used with the equipment shall not be taken into account.

For MOVABLE EQUIPMENT having a total mass not exceeding 18 kg, the material of a FIRE ENCLOSURE, in the thinnest significant wall thickness used, shall be of V-1 CLASS MATERIAL or shall pass the test of Clause A.2.

For MOVABLE EQUIPMENT having a total mass exceeding 18 kg and for all STATIONARY EQUIPMENT, the material of a FIRE ENCLOSURE, in the thinnest significant wall thickness used, shall be of 5VB CLASS MATERIAL or shall pass the test of Clause A.1.

Materials for components that fill an opening in a FIRE ENCLOSURE, and that are intended to be mounted in this opening shall:

– be of V-1 CLASS MATERIAL; or

– pass the tests of Clause A.2; or

– comply with the flammability requirements of the relevant IEC component standard.

NOTE Examples of these components are fuseholders, switches, pilot lights, connectors and appliance inlets.

Plastic materials of a FIRE ENCLOSURE shall be located more than 13 mm through air from arcing parts such as unenclosed commutators and unenclosed switch contacts.

Plastic materials of a FIRE ENCLOSURE located less than 13 mm through air from non-arcing parts which, under any condition of normal or abnormal operation, could attain a temperature sufficient to ignite the material, shall be capable of passing the test of IEC 60695-2-20. The average time to ignition of the samples shall be not less than 15 s. If a sample melts through without igniting, the time at which this occurs is not considered to be the time to ignition.

Compliance is checked by inspection of the equipment and material data sheets and, if necessary, by the appropriate test or tests in Annex A or IEC 60695-2-20.

4.7.3.3 Materials for components and other parts outside fire enclosures

Except as otherwise noted below, materials for components and other parts (including MECHANICAL ENCLOSURES, ELECTRICAL ENCLOSURES and DECORATIVE PARTS), located outside FIRE ENCLOSURES, shall be of

– HB75 CLASS MATERIAL if the thinnest significant thickness of this material is < 3 mm, or

– HB40 CLASS MATERIAL if the thinnest significant thickness of this material is ≥ 3 mm, or

– HBF CLASS FOAMED MATERIAL.

NOTE Where a MECHANICAL ENCLOSURE or an ELECTRICAL ENCLOSURE also serves as a FIRE ENCLOSURE, the requirements for FIRE ENCLOSURES apply.

Requirements for materials in air filter assemblies are in 4.7.3.5 and for materials in high-voltage components in 4.7.3.6.

Connectors shall comply with one of the following:

– be made of V-2 CLASS MATERIAL; or

– pass the tests of Clause A.2; or

– comply with the flammability requirements of the relevant IEC component standard; or

– be mounted on V-1 CLASS MATERIAL and be of a small size; or

– be located in a SECONDARY CIRCUIT supplied by a power source that is limited to a maximum of 15 VA (see 1.4.11) under normal operating conditions and after a single fault in the equipment (see 1.4.14).

The requirement for materials for components and other parts to be of HB40 CLASS MATERIAL, HB75 CLASS MATERIAL, or HBF CLASS FOAMED MATERIAL, does not apply to any of the following:

– electrical components that do not present a fire hazard under abnormal operating conditions when tested according to 5.3.7;

– materials and components within an ENCLOSURE of 0,06 m^3 or less, consisting totally of metal and having no ventilation openings, or within a sealed unit containing an inert gas;

– meter cases (if otherwise determined to be suitable for mounting of parts at HAZARDOUS VOLTAGE), meter faces and indicator lamps or their jewels;

– components meeting the flammability requirements of a relevant IEC component standard that includes such requirements;

– electronic components, such as integrated circuit packages, optocoupler packages, capacitors and other small parts that are:

  - mounted on V-1 CLASS MATERIAL; or
  - supplied from a power source of no more than 15 VA (see 1.4.11) under normal operating conditions or after a single fault in the equipment (see 1.4.14) and mounted on HB75 CLASS MATERIAL if the thinnest significant thickness of this material is < 3 mm, or HB40 CLASS MATERIAL if the thinnest significant thickness of this material is ≥ 3 mm;

– wiring, cables and connectors insulated with PVC, TFE, PTFE, FEP, polychloroprene or polyimide;

– individual clamps (not including helical wraps or other continuous forms), lacing tape, twine and cable ties used with wiring harnesses;

– gears, cams, belts, bearings and other small parts that would contribute negligible fuel to a fire, including DECORATIVE PARTS, labels, mounting feet, key caps, knobs and the like;

– supplies, consumable materials, media and recording materials;

– parts that are required to have particular properties in order to perform intended functions, such as rubber rollers for paper pick-up and delivery, and ink tubes.

Compliance is checked by inspection of the equipment and material data sheets and, if necessary, by the appropriate test or tests in Annex A.

4.7.3.4 Materials for components and other parts inside fire enclosures

Requirements for materials in air filter assemblies are in 4.7.3.5 and requirements for materials in high-voltage components in 4.7.3.6. [A2] Requirements for voltage dependent resistors (VDR's) are in Annex Q. [A2]

Inside FIRE ENCLOSURES, materials for components and other parts, (including MECHANICAL ENCLOSURES and ELECTRICAL ENCLOSURES located inside FIRE ENCLOSURES), shall comply with one of the following:

– be of V-2 CLASS MATERIAL or HF-2 CLASS FOAMED MATERIAL; or

– pass the flammability test described in Clause A.2; or

– meet the flammability requirements of a relevant IEC component standard that includes such requirements.

The above requirement does not apply to any of the following:

– electrical components that do not present a fire hazard under abnormal operating conditions when tested according to 5.3.7;

– materials and components within an ENCLOSURE of 0,06 m^3 or less, consisting totally of metal and having no ventilation openings, or within a sealed unit containing an inert gas;

– one or more layers of thin insulating material, such as adhesive tape, used directly on any surface within a FIRE ENCLOSURE, including the surface of current-carrying parts, provided that the combination of the thin insulating material and the surface of application complies with the requirements of V-2 CLASS MATERIAL, or HF-2 CLASS FOAMED MATERIAL;

NOTE Where the thin insulating material referred to in the above exclusion is on the inner surface of the FIRE ENCLOSURE itself, the requirements in 4.6.2 continue to apply to the FIRE ENCLOSURE.

– meter cases (if otherwise determined to be suitable for mounting of parts at HAZARDOUS VOLTAGE), meter faces and indicator lamps or their jewels;

– electronic components, such as integrated circuit packages, optocoupler packages, capacitors and other small parts that are mounted on V-1 CLASS MATERIAL;

– wiring, cables and connectors insulated with PVC, TFE, PTFE, FEP, polychloroprene or polyimide;

– individual clamps (not including helical wraps or other continuous forms), lacing tape, twine and cable ties used with wiring harnesses;

– the following parts, provided that they are separated from electrical parts (other than insulated wires and cables), which under fault conditions are likely to produce a temperature that could cause ignition, by at least 13 mm of air or by a solid barrier of V-1 CLASS MATERIAL:

  - gears, cams, belts, bearings and other small parts that would contribute negligible fuel to a fire, including, labels, mounting feet, key caps, knobs and the like;
  - supplies, consumable materials, media and recording materials;
  - parts that are required to have particular properties in order to perform intended functions, such as rubber rollers for paper pick-up and delivery, and ink tubes;
  - tubing for air or any fluid systems, containers for powders or liquids and foamed plastic parts, provided that they are of HB75 CLASS MATERIAL if the thinnest significant thickness of the material is < 3 mm, or HB40 CLASS MATERIAL if the thinnest significant thickness of the material is ≥ 3 mm, or HBF CLASS FOAMED MATERIAL.

Compliance is checked by inspection of the equipment and material data sheets and, if necessary, by the appropriate test or tests of Annex A.

4.7.3.5 Materials for air filter assemblies

Air filter assemblies shall be constructed of V-2 CLASS MATERIAL, or HF-2 CLASS FOAMED MATERIAL.

This requirement does not apply to the following constructions:

– air filter assemblies in air circulating systems, whether or not airtight, that are not intended to be vented outside the FIRE ENCLOSURE;

– air filter assemblies located inside or outside a FIRE ENCLOSURE, provided that the filter materials are separated by a metal screen from parts that could cause ignition. This screen may be perforated and shall meet the requirements of 4.6.2 for the bottoms of FIRE ENCLOSURES;

– air filter assemblies constructed of

  - HB75 CLASS MATERIAL if the thinnest significant thickness of this material is < 3 mm, or
  - HB40 CLASS MATERIAL if the thinnest significant thickness of this material is ≥ 3 mm, or
  - HBF CLASS FOAMED MATERIAL,

  provided that they are separated by at least 13 mm of air, or by a solid barrier of V-1 CLASS MATERIAL, from electrical parts (other than insulated wires and cables) which under fault conditions are likely to produce a temperature that could cause ignition.

Compliance is checked by inspection of the equipment and material data sheets and, if necessary, by appropriate tests.

4.7.3.6 Materials used in high-voltage components

High-voltage components operating at peak-to-peak voltages exceeding 4 kV shall either be of V-2 CLASS MATERIAL, or HF-2 CLASS FOAMED MATERIAL, or comply with 14.4 of IEC 60065 or pass the needle flame test according to IEC 60695-11-5.

Compliance is checked by inspection of the equipment and material data sheets and, if necessary, by

– *the tests for V-2 CLASS MATERIAL or HF-2 CLASS FOAMED MATERIAL; or*

– *the test described in 14.4 of IEC 60065; or*

– *the needle flame test according to IEC 60695-11-5.*

In addition, the following details apply, referring to clauses of IEC 60695-11-5:

Clause 7 – Severities

The test flame is applied for 10 s. If a self-sustaining flame does not last longer than 30 s, the test flame is applied again for 1 min at the same point or at any other point. If again a self-sustaining flame does not last longer than 30 s, the test flame is then applied for 2 min at the same point or at any other point.

Clause 8 – Conditioning

Except for high voltage transformers and high voltage multipliers the samples are stored for 2 h in an oven at a temperature of 100 °C ± 2 °C.

For high voltage transformers, a power of 10 W (d.c. or a.c. at mains frequency) is initially supplied to the high-voltage winding. This power is maintained for 2 min, after which it is increased by successive steps of 10 W at 2 min intervals to 40 W.

The treatment lasts 8 min or is terminated as soon as interruption of the winding or appreciable splitting of the protective covering occurs.

NOTE 1 Certain transformers are so designed that this preconditioning cannot be conducted. In such cases the oven preconditioning applies.

For high-voltage multipliers, a voltage taken from an appropriate high-voltage transformer, is supplied to each sample, its output circuit being short-circuited.

The input voltage is adjusted so that the short-circuit current is initially 25 mA ± 5 mA. This current is maintained for 30 min or is terminated as soon as any interruption of the circuit or appreciable splitting of the protective covering occurs.

NOTE 2 Where the design of a high-voltage multiplier is such that a short-circuit current of 25 mA cannot be obtained, a preconditioning current is used, which represents the maximum attainable current, determined either by the design of the multiplier or by its conditions of use in a particular apparatus.

Clause 11 – Evaluation of test results

After the first application of the test flame, the test sample shall not be consumed completely.

After any application of the test flame, any self-sustaining flame shall extinguish within 30 s. No burning of the WRAPPING TISSUE shall occur and the board shall not be scorched.

Table 4E – Summary of material flammability requirements

Part		Requirement
FIRE ENCLOSURES 4.7.3.2	MOVABLE EQUIPMENT > 18 kg and STATIONARY EQUIPMENT	– 5VB – Test A.1 – Hot wire test of IEC 60695-2-20 (If <13 mm of air from parts at high temperatures that could cause ignition)
	MOVABLE EQUIPMENT ≤ 18 kg	– V-1 – Test A.2 – Hot wire test of IEC 60695-2-20 (If < 13 mm of air from parts at high temperatures that could cause ignition)
	Parts that fill an opening	– V-1 – Test A.2 – Component standard
Components and parts, including MECHANICAL ENCLOSURES and ELECTRICAL ENCLOSURES, outside FIRE ENCLOSURES 4.7.3.1 and 4.7.3.3		– HB40 for thicknesses ≥ 3 mm – HB75 for thicknesses < 3 mm – HBF – Glow-wire test 550 °C of IEC 60695-2-11 For connectors and exceptions see 4.7.3.3
Components and parts, including MECHANICAL ENCLOSURES and ELECTRICAL ENCLOSURES, inside FIRE ENCLOSURES 4.7.3.4		– V-2 – HF-2 – Test A.2 – Component standard For exceptions see 4.7.3.4
Air filter assemblies 4.7.3.5		– V-2 – HF-2 – Test A.2 For exceptions see 4.7.3.5
High voltage (> 4 kV) components 4.7.3.6		– V-2 – HF-2 – Test of 14.4 of IEC 60065 – Needle flame test of IEC 60695-11-5

5 Electrical requirements and simulated abnormal conditions

5.1 Touch current and protective conductor current

In this subclause measurements of current through networks simulating the impedance of the human body are referred to as measurements of TOUCH CURRENT.

Except for application of 5.1.8.2, these requirements do not apply to equipment intended to be supplied by only a DC MAINS SUPPLY.

5.1.1 General

Equipment shall be so designed and constructed that neither TOUCH CURRENT nor PROTECTIVE CONDUCTOR CURRENT is likely to create an electric shock hazard.

Compliance is checked by testing in accordance with 5.1.2 to 5.1.7 inclusive, and, if relevant, 5.1.8 (see also 1.4.4).

However, if it is clear from a study of the circuit diagrams of either STATIONARY PERMANENTLY CONNECTED EQUIPMENT or STATIONARY PLUGGABLE EQUIPMENT TYPE B, that has a PROTECTIVE EARTHING CONDUCTOR, that the TOUCH CURRENT will exceed 3,5 mA r.m.s., but that the PROTECTIVE CONDUCTOR CURRENT will not exceed 5 % of input current, the tests of 5.1.5, 5.1.6 and 5.1.7.1 a) are not made.

NOTE In the above case, the requirement of 5.1.7.1 b) continues to apply.

5.1.2 Configuration of equipment under test (EUT)

5.1.2.1 Single connection to an a.c. mains supply

Systems of interconnected equipment with individual connections to the AC MAINS SUPPLY shall have each piece of equipment tested separately. Systems of interconnected equipment with one common connection to the AC MAINS SUPPLY shall be treated as a single piece of equipment. See also 1.4.10 regarding the inclusion of optional features.

NOTE Systems of interconnected equipment are specified in more detail in Annex A of IEC 60990.

5.1.2.2 Redundant multiple connections to an a.c. mains supply

Equipment that is designed for multiple connections to the AC MAINS SUPPLY, only one of which is required at a time, shall be tested with only one connection.

5.1.2.3 Simultaneous multiple connections to an a.c. mains supply

Equipment requiring power simultaneously from two or more AC MAINS SUPPLIES shall be tested with all AC MAINS SUPPLIES connected.

The total TOUCH CURRENT through all PROTECTIVE EARTHING CONDUCTORS that are connected to each other and to earth is measured.

A PROTECTIVE EARTHING CONDUCTOR that is not connected within the equipment to other earthed parts in the equipment shall not be included in the above tests. If an a.c. power source has such a PROTECTIVE EARTHING CONDUCTOR it shall be tested separately according to 5.1.2.1 (see also 5.1.7.2).

5.1.3 Test circuit

Equipment is tested using the test circuit in Figure 5A (for single-phase equipment to be connected only to a star TN or TT power distribution system) or Figure 5B (for three-phase equipment to be connected only to a star TN or TT power distribution system) or where appropriate, another test circuit from Figures 7, 9, 10, 12, 13 or 14 of IEC 60990.

The use of a test transformer for isolation is optional. For maximum protection, a test transformer for isolation (T in Figures 5A and 5B) is used and the main protective earthing terminal of the EUT is earthed. Any capacitive leakage in the transformer shall then be taken into account. As an alternative to earthing the EUT, the test transformer secondary and the EUT are left floating (not earthed) in which case capacitive leakage in the transformer need not be taken into account.

If transformer T is not used, the EUT and the test circuitry shall not be earthed. The EUT is mounted on an insulating stand, and appropriate safety precautions are taken in view of the possibility of the BODY of the equipment being at a HAZARDOUS VOLTAGE.

Equipment to be connected to an IT power distribution system is tested accordingly (see Figures 9, 10 and 12 of IEC 60990). Such equipment may also be connected to a TN or TT power distribution system without further test.

Single-phase equipment intended to be operated between two line conductors is tested using a three-phase test circuit such as Figure 5B.

If it is inconvenient to test equipment at the most unfavourable supply voltage (see 1.4.5), it is permitted to test the equipment at any available voltage within the tolerance of RATED VOLTAGE or within the RATED VOLTAGE RANGE, and then calculate the results.