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Standard

Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations Type of Protection — *Encapsulation "m"*

Certain provisions of this document differ from analogous provisions of ANSI/UL 2279. ISA and UL are actively working to harmonize these provisions and anticipate jointly publishing a single set of American National Standards when these differences are resolved.

ISA-S12.23.01 (IEC 79-18 Mod), Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – *Encapsulation "m"*

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ISA
67 Alexander Drive
P. O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

This ISA standard is based on IEC Publication 79-18. It is the intention of the ISA SP12 Committee to develop an ANSI Standard that is harmonized with IEC 79-18 to the fullest extent possible.

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Contents

Foreword

The entire text of IEC 79-18:1992 is included in this document. U.S. National Deviations are shown by ~~strikeout~~ through deleted text and underlining of added text. There are four annexes in this standard. Annexes A, B, and C are normative and form part of the requirements of this standard. Annex D is informative and is not considered part of this standard.

1 Scope

This standard ~~part of IEC 79~~ prescribes the specific requirements for construction and testing of electrical apparatus, parts of electrical apparatus and Ex components which have rated voltages not exceeding 11 kV with the type of protection encapsulation “m”.

These specific requirements supplement ~~IEC 79-0~~ ISA-dS12.0.01 (IEC 79-0 Mod) “General Requirements,” with the following exceptions:

Clauses of ~~IEC 79-0~~ ISA-dS12.0.01 (IEC 79-0 Mod) that are not applicable	
4.2	Maximum surface temperature (for Ex components)
5.2	Time delay before opening an enclosure
6.2	Threaded holes in enclosures of plastic material
8	Fasteners
9	Interlocking devices
15	Cable and conduit entries
17	Switchgear
18	Fuses
20.2	Warning label for luminaires
22.4.3.1	Test for resistance to impact (for Ex components)
22.4.4	Test for degree of protection for enclosures
22.4.8	Test in explosive mixtures
22.4.9	Test of clamping on non-armored cables in cable entries
22.4.10	Test of clamping of armored cables in cable entries

2 Normative references

The following ~~normative~~ documents contain provisions which, through reference in this text, constitute provisions of this standard ~~part of IEC 79~~. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this standard ~~part of IEC 79~~ are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintains registers of currently valid U.S. National Standards.

IEC 44-4	1980	*Instrument transformers - Part 4: Measurement of partial discharges*
~~IEC 79-0~~	~~1983~~	~~*Electrical apparatus for explosive gas atmospheres - Part 0: General requirements*~~
	~~1987~~	~~*Amendment 1*~~
	~~1991~~	~~*Amendment 2*~~
ISA-S12.0.01 (IEC 79-0 Mod)	1996	*Electrical Apparatus For Use in Class I, Zones 0 & 1 Hazardous (Classified) Locations - General Requirements*
~~IEC 79-7~~	~~1990~~	~~*Electrical apparatus for explosive gas atmospheres - Part 7: Increased safety "e"*~~
ISA-dS12.16.01 (IEC 79-7 Mod)		*Electrical Apparatus For Use in Class I, Zone 1 Hazardous (Classified) Locations - Increased Safety "e"*
~~IEC 79-11~~	~~1991~~	~~*Electrical apparatus for explosive gas atmospheres - Part 11: Intrinsic safety "i"*~~
ISA-ddS12.2.01 (IEC 79-11 Mod)		*Electrical Apparatus For Use in Class I, Zones 0 & 1 Hazardous (Classified) Locations - Intrinsic Safety "i"*
~~IEC 127~~	~~1974~~	~~*Miniature fuses - Cartridge fuse-links for miniature fuses*~~
~~IEC 269-1~~	~~1986~~	~~*Low voltage fuses - Part 1: General requirements*~~
~~IEC 276-1~~	~~1986~~	~~*Low voltage fuses: Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly used for industrial application)*~~
~~IEC 269-2-1~~	~~1987~~	~~*Low voltage fuses: Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly used for industrial application) Section 1: Examples of types of standardized fuses for use by authorized persons*~~
~~IEC 269-3~~	~~1987~~	~~*Low voltage fuses - Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)*~~
~~IEC 269-4~~	~~1986~~	~~*Low voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices*~~
ANSI/UL 248	1994	*Low-Voltage Fuses*
ANSI/UL 746C	1989	*Polymeric Materials - Use in Electrical Equipment Evaluations*
~~ISO 62~~	~~1980~~	~~*Plastics- Determination of water absorption*~~
~~ISO 179~~	~~1982~~	~~*Plastics- Determination of Charpy impact strength or rigid materials*~~
~~ISO 1817~~	~~1985~~	~~*Rubber, vulcanized - Determination of the effet of liquids*~~
ISO 4892	1981	Plastics- Methods of exposure to laboratory light sources

3 Definitions

The following definitions specific to the type of protection encapsulation “m” are applicable to this standard ~~part of IEC 79~~; they supplement the definitions that are given in ~~IEC 79-0~~ ISA S12.0.01 (IEC 79-0 Mod).

3.1 encapsulation “m”: A type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited.

3.2 compounds: Thermosetting, thermoplastic, epoxy resin (cold curing) and elastometric materials with or without fillers and/or additives, are considered, after their solidification, to be compounds.

3.3 temperature range of the compound: The range of temperatures within which the properties of the compound, in either operation or storage, permit compliance with the requirements of this standard.

3.4 continuous operating temperature of the compound: The maximum temperature to which the compound can be subjected continuously according to the data given by the manufacturer of the compound.

3.5 encapsulation: The process of applying the compound to enclose any electrical device(s) by suitable means such as embedding or potting.

3.6 embedding: The process of completely encasing any electrical device(s) by pouring a compound over it (them) in a mold, and removing the enclosed device(s) from the mold after solidification of the compound.

3.7 potting: An embedding process in which the mold remains attached to the encased electrical device(s).

~~**3.8 Ex component:** Part of electrical apparatus for explosive atmospheres which is not to be used alone in such atmospheres and which requires additional certification of any electrical apparatus with which it is used.~~

~~**Note -** This definition will be transferred in due course to IEC 79-0.~~

4 Requirements for compounds

4.1 Documents presented by the manufacturer ~~and verified by the national or other appropriate authority in accordance with 22.2 of IEC 79-0~~ shall describe precisely the compound(s) used as well as the production method during encapsulation.

4.2 The description shall include:

- the name and address of the manufacturer of the material;
- the exact and complete reference of the material, its color as well as the kind and percentage of fillers and other additives, when they are included;
- ~~**NOTE -** An ISO designation should be used where possible.~~
- surface treatments, such as varnishes etc., where they are used;
- the temperature range of the compound(s);
- the continuous operating temperature of the compound(s).

~~**4.3** The national or other appropriate authority is not required to verify compliance of the material with its description~~

5 Constructional requirements for all electrical apparatus

5.1 General

5.1.1 The choice of the compound(s) to be used for a specific application is dependent on the task each compound has to perform. Only the properties of the compound(s) on which the type of protection “m” depends shall be taken into account.

The requirements of 6.3 (electrostatic charges of enclosures of plastic material) of ~~IEC 79-0~~ ISA-dS12.0.01 (IEC 79-0 Mod) apply to the surface of the compound in encapsulated electrical apparatus or encapsulated parts of electrical apparatus or encapsulated Ex components when such surface is freely exposed to the environment.

The requirements of 6.3 of ~~IEC 79-0~~ ISA-dS12.0.01 (IEC 79-0 Mod) do not apply when encapsulated parts of electrical apparatus or encapsulated Ex components are designed to be mounted within an additional enclosure.

5.1.2 The encapsulation shall be made without voids, but it is permitted to encapsulate components (relays, transistors, etc.) each designed with an internal free volume of up to ~~100~~ 10 cm^3. The thickness of the compound between such components shall be at least 3 mm; where the void is less than 1 cm^3, the thickness of the compound may be reduced to 1 mm.

Switching contacts shall have an additional housing before encapsulation. If the rated contact current exceeds 6 A, the additional housing shall be inorganic.

Loose filling materials shall not be used for the purpose of reducing the free volume inside a void to the specified upper limit.

5.1.3 Encapsulated electrical apparatus, encapsulated parts of electrical apparatus, or encapsulated Ex components designed to be connected to an external source of supply shall be suitable for a prospective short circuit current of ~~4000 A~~ 1500 A unless the marking or manufacturer's documentation includes the value of the permitted prospective short circuit current.

5.1.4 The type of protection encapsulation "m" shall be maintained even in the case of recognized overloads and of any single internal electrical fault which could cause either an overvoltage or overcurrent, for example, a short circuit or other failure of any component, including a change in its characteristics, a fault in printed circuitry, etc. For criteria of acceptance, see 8.2.1.3.

NOTE – If a fault can lead to one or more subsequent faults, e.g., overrating of another component, the primary and subsequent faults are considered to be a single fault.

Components as specified in 5.1.5 and distances as specified in 5.3 are considered as not subject to fault.

5.1.5 Components

a) The following components shall be considered as not subject to a short circuit fault or to a lower resistance than the rated value when encapsulated in accordance with this standard and when, in normal operation, they are used at no more than two-thirds of either their rated voltage or power, as specified by the component manufacturer:

- film type resistors;
- wire resistors with a single layer in helical form;
- coils with a single layer in helical form.

b) The following components shall be considered as not subject to short circuit fault or lower resistance or higher capacitance than the rated value when encapsulated in accordance with this standard and when, in normal operation, they are used at no more than two-thirds of their rated voltage, as specified by the component manufacturer:

- plastic foil capacitors;
- paper capacitors;
- ceramic capacitors.

c) Optocouplers and relays used for segregation of different circuits, when encapsulated in accordance with this standard, shall be considered as not subject to breakdown between the segregated circuits when:

   i. the sum *U* of the rms values of the voltages of the circuits is not more than 1000 V, and

   ii. the electric strength of the components, when tested by the method of 8.2.3 is at least 1.5 *U*.

d) Transformers, coils and motor windings encapsulated in accordance with this standard shall be considered as not subject to inter-turn short circuits, and the transformers shall be considered as not subject to breakdown between windings when:

   i. they comply with ~~IEC 79-7~~ ISA-S12.16.01 (IEC 79-7 Mod), including those with wire diameters less than 0.25 mm, and

   ii. they are also protected against inadmissible internal temperatures.

e) Transformers shall be considered as not subject to inter-turn short circuits or to breakdown between windings when they comply with 8.1 of ~~IEC 79-11~~ ISA-S12.2.01 (IEC 79-11 Mod), except those of type 2(a) of 8.1 of ~~IEC 79-11~~ ISA-S12.2.01 (IEC 79-11 Mod).

5.1.6 The fixing of the encapsulated electrical apparatus, encapsulated parts of Electrical Apparatus or encapsulated Ex component shall not affect the type of protection encapsulation "m".

5.2 Thickness of the layer of compound

5.2.1 The thickness of the compound between the free surface of the compound and the components/conductors in the encapsulation shall be at least 3 mm.

However, for small encapsulated electrical apparatus, encapsulated parts of electrical apparatus or encapsulated Ex components having no free surface exceeding 2 cm^2, a thickness of at least 1 mm is allowed. If in this case the impact test according to ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) or the dielectric strength test of 8.2.3 of this standard cannot be passed on the encapsulated electrical apparatus or encapsulated parts of electrical apparatus, ~~the national or other appropriate authority shall issue a certificate having the sign "X" and~~ the manufacturer's instructions shall include a requirement for ~~requiring~~ other means of protection, e.g., an additional mechanical protection.

5.2.2 Where the encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex component includes a metal protective housing (potting), the thickness of the layer between the housing and any component or conductor shall be at least 1 mm.

However, for rotating machines with windings in slots, the slot insulation shall have a minimum thickness of 0,2 mm and shall be elongated at the end of the slot by at least 5 mm and shall be protected by the required thickness of compound in accordance with 5.2.1.

5.2.3 Where the encapsulated electrical apparatus, encapsulated parts of electrical apparatus or tthe encapsulated Ex component includes a protective housing made of insulating material (potting), no minimum thickness of the layer between the protective housing and any component or conductor is required if the thickness of the protective housing is at least 1 mm; if this thickness is less than 1 mm, the sum of the thicknesses of the protective housing and compound layer shall comply with 5.2.1.

~~The protective housing made of insulating material shall pass successfully the tests according to Annex C.~~

~~Where a protective housing or a part of a protective housing of non-metallic material serves directly to support live bare parts the resistance to tracking and creepage distances on the surface of the walls of the protective housing shall comply with the requirements of 4.4 of IEC 79-7.~~

5.3 Distances through the compound

It is not necessary to consider the possibility of a fault occurring as described in 5.1.4 if the distances between live bare parts, mechanically fixed in relation to each other before encapsulating:

- of the same circuit;
- of a circuit and earthed (grounded) metallic parts;
- of two separate circuits;

are at least equal to the values of table 1.

Table 1 – Minimum distance through the compound

Rated Voltage for the insulation, r.m.s. V	**Minimum distance mm**
380	1
500	1.5
660	2
1000	2.5
1500	4
3000	7
6000	12
10000	20
NOTE – The rated voltage may exceed the values stated in the table by 10%.	

The distances between live parts of encapsulated electronic assemblies (e.g. printed circuit boards) are not to be considered as distances through the compound.

5.4 Temperature limitation

None of the values of the marked maximum surface temperature, temperature class or continuous operating temperature of the compound shall be exceeded in normal service.

The encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex component shall be protected so that under electrical fault conditions in accordance with 5.1.3 and 5.1.4 the type of protection encapsulation “m” is not affected.

This may be achieved by a non-self-resetting internal or external, electrical or thermal protecting device.

NOTE – The encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex component may contain additionally a self-resetting protecting device.

5.5 External connections

5.5.1 The entrance of all electrical conductors including cables into the compound shall be achieved in such a way as to ensure a seal against the possible entry of explosive atmosphere into the encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex component. This can be obtained, for example, by having a length of at least 5 mm of bare electrical conductor within the compound.

5.5.2 In the case where connection is made by cable permanently connected to the encapsulated electrical apparatus or encapsulated parts of electrical apparatus, the pull test in accordance with 8.2.2 shall be carried out.

5.6 Protection of ~~bare~~ live parts

~~Bare~~ Live parts which pass through the surface of the compound shall be protected by one of the types of protection listed in 1.1 of ~~IEC 79-0~~ ISA-dS12.0.01 (IEC 79-0 Mod).

5.7 Adhesion

Where parts are not completely embedded in the compound, for example a printed circuit board which is partially encapsulated, the adhesion of the compound to such parts shall be assured by the use of a procedure specified by the manufacturer of the assembly, such as casting, gluing and/or varnishing procedures, preceded by an etching of this surface if necessary, in such a way that no moisture can enter between the compound and the parts.

No visible separation shall be detectable after the tests of 8.2.1.

6 Supplementary requirements for specific electrical apparatus

These requirements supplement those of clause 5 of this standard which are also applicable, unless otherwise stated, to the specific electrical apparatus considered in 6.1 and 6.2.

6.1 Primary and secondary cells, batteries and accumulators

Only cells, batteries and accumulators, which in normal use under the specified conditions given by their manufacturer are not expected to release gas, do not release electrolyte or produce excessive temperature rise, may be encapsulated.

The encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex components shall:

(1) be so constructed as to allow ~~a~~ venting to the outside atmosphere of any gas which may be generated unless precautions ~~acceptable to the national or other appropriate authority~~ are applied to avoid gas release or cell deformation affecting the type of protection encapsulation “m”, and shall

(2) not allow the release of electrolyte, and shall

(3) not produce excessive temperature rise that may affect the type of protection encapsulation “m”.

When encapsulating cells, batteries or accumulators in a compound, it is necessary to consider the expansion tolerances, e.g. by the application of flexible elastomer around the cell, battery or accumulator so that no undue pressure can be applied to the compound.

Where the charging device is not within the same enclosure, the ~~certificate~~ manufacturer’s instructions shall indicate the required charging conditions. ~~and the apparatus shall be marked “X” in accordance with 25.2.9 of IEC 79-0~~.

Tests according to 8.2.4 shall be passed successfully.

6.2 Fuses

The fusing element shall be of the enclosed type before encapsulation, e.g. in glass or ceramic.

~~For voltages above 60 V,~~ Fuses shall comply with ANSI/UL 248-1 and shall have a voltage rating not less than the supply circuit and shall have a breaking capacity not less than the available short circuit current of the supply. ~~in accordance with IEC 127-1 or IEC 269-1~~.

The maximum temperature caused by the rupturing of the fuse may exceed the continuous operating temperature of the compound on condition that the type of protection encapsulation

“m” is not affected, e.g. by cracks. However, the surface temperature of the encapsulated electrical apparatus or encapsulated parts of electrical apparatus shall not exceed the marked temperature or temperature class.

7 Sampling

The following numbers of samples shall be subjected to testing in accordance with Section 8: ~~submitted for tests by the national or other appropriate authority.~~

~~For apparatus of group I~~

~~1 sample non-filled with compound;~~

~~4 samples filled with compound.~~

~~For apparatus of group II:~~

1 sample non-filled with compound

2 samples filled with compound

8 Type verifications and type tests

These requirements supplement those of clause 22 of ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) which are also applicable, unless otherwise stated, to the type of protection encapsulation “m”.

~~The sequence of the tests for group I apparatus and compounds are indicated in annex B (B.1).~~

The sequence of the tests for ~~group II~~ apparatus and compounds are indicated in annex B (B.2).

8.1 Tests for compounds

8.1.1 Dielectric strength test

A disk of compound 50 mm ± 2 mm in diameter and 3 mm ± 0,2 mm thick shall be tested with a voltage of 4 kV and with a frequency between 48 Hz and 62 Hz, between electrodes of 30 mm ± 2 mm diameter placed at the center of the disk. The voltage shall be applied for at least 5 min at the highest temperature of the temperature range defined in 3.3.

No flashover or breakdown shall occur during the test.

8.1.2 Water absorption test

This test shall be carried out only on samples of the compound(s) which are intended to be used in a moist environment during the operation of the encapsulated electrical apparatus.

Three dry ~~(see ISO 62)~~ samples of this (these) compound(s), of 50 mm ± 2 mm in diameter and 3 mm ± 0,2 mm thick are weighed. They are then immersed for 24 h in tap water at temperature of 23° C ± 2K. They are then taken out of the water, wiped off and weighed again. The increase in mass shall not exceed 1 %.

Where this test has not been performed or for compounds not meeting this requirement, the manufacturer's instructions ~~apparatus shall be marked "X" and the associated documentation~~ shall indicate restrictions of use.

8.2 Tests for encapsulated electrical apparatus, encapsulated parts of electrical apparatus and encapsulated Ex components

8.2.1 Thermal tests

8.2.1.1 Maximum temperatures

A sample of encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex component shall be subjected to a type test to ensure that:

- the temperature limits defined in 5.4 are not exceeded in normal service; and
- the maximum surface temperature is not exceeded under fault conditions defined in 5.1.4.

For the encapsulated electrical apparatus, encapsulated parts of electrical apparatus and encapsulated Ex components with external load, the test shall be carried out by adjusting the current to the highest value which does not cause the protective device to operate.

The final temperature is considered to be reached when its rate of rise does not exceed 2K/h.

NOTE – The protective device may be a fuse complying with ~~IEC 127~~ ANSI/UL 248 and the test current may be 1.7 I_n (where I_n is the fuse rating).

8.2.1.2 Thermal cycling test

The sample shall be fitted with one or more temperature sensors placed in the compound at locations determined ~~places judged by the national or other appropriate authority~~ to be the hottest. If the sample contains windings, the temperature may be measured by a change of electrical resistance of these windings.

The following test procedure is shown diagrammatically in annex A.

The electrical power shall be switched off from the sample and the sample shall be completely at room temperature of 21° C ± 2K. It is then brought into an environment of (T_{Amax} +10)° C ± 2K where T_{Amax} is the specified maximum ambient temperature in service. It is considered that the temperature of the sample has stabilized when the difference between the inside and outside temperatures of the sample is less than 2K. After the sample has reached the stabilized temperature of (T_{Amax} +10)° C ± 2K, it is energized within a range of 90% to 110% of the rated voltage, at a voltage which gives the most unfavorable condition unless:

- other documents prescribe other tolerances or overloads for equivalent industrial apparatus; or
- the sample has one or more internal thermal protective devices. In this case the sample need only be energized by using voltage which produces a temperature level that just does not cause the non-self-resetting thermal protective device to operate.

NOTE – Internal thermal protective devices may be bridged ~~by the national or other appropriate authority~~ for test purposes.

The internal temperature change is observed until a stable temperature distribution is reached. It is assumed that this is the case when the gradient of the internal temperature has become less than 2K/h. The minimum duration of energization is one hour.

The internal temperature shall not exceed the specified continuous operating temperature of the compound (see 3.4 and 5.4).

The sample is de-energized, removed from the (T_{Amax} +10)° C environment and allowed to cool to room temperature. The 2 K temperature differential between the inside and outside of the sample is again taken as the criterion of having reached room temperature.

The sample is now brought into an environment of (T_{Amin} -5)° C ± 2K where T_{Amin} is the specified minimum ambient temperature.

It is considered that the temperature of the sample has stabilized when the difference between the inside and the outside of the sample is less than 2 K.

After the sample has reached the stabilized temperature of (T_{Amin} -5)° C ± 2K, it is again energized within a range of 90 percent to 110 percent of the rated voltage, at a voltage which gives the most unfavorable condition of the electrical apparatus unless other documents prescribe other tolerances or overloads for equivalent industrial apparatus.

The internal temperature change is observed until a stable temperature distribution is reached. It is assumed that this is the case when the gradient of the internal temperature has become less than 2 K/h. The minimum duration of energization is half an hour.

The same sample is then de-energized and allowed to cool to (T_{Amin} -5)° C ± 2K. The minimum duration for cooling is half an hour unless the 2 K temperature differential criterion requires a longer time.

The power is again switched on and the energizing and de-energizing cycle is repeated. In all, three complete cycles are to be carried out before the sample is removed from the (T_{Amin} -5)° C environment and allowed to reheat to room temperature.

8.2.1.3 Acceptance criteria

After the thermal tests the sample shall be subjected to visual inspection; no visible damage of the compound that could impair the type of protection shall be evident, such as cracks in the compound, exposure of encapsulated parts, flaking, impermissible shrinkage, swelling, decomposition, or softening. In addition, the compound shall not show evidence of overheating.

8.2.2 Cable pull test

This test shall not be carried out on Ex components.

The test required in 5.5.2 shall be carried out in the following way:

A tensile force corresponding to a value in newtons equal to:

- either 20 times the value in millimeters of the diameter of the cable; or
- 50 times the mass in kilograms of the encapsulated electrical apparatus;

whichever is the smaller value but at least 1 N shall be applied on the cable in the direction of the cable entrance into the compound for a duration of 1 h.

No visible displacement between the compound and the cable shall be observed.

8.2.3 Dielectric strength tests

The dielectric strength tests shall be carried out as follows:

a) between galvanically separated circuits;

b) between each circuit and all the earthed (grounded) parts;

c) between each circuit and the surface of the compound which may be clad if necessary, with a conductive foil.

The test voltage shall be 500 V rms for apparatus with supply voltages not exceeding 90 V peak and it shall be 2 *U* + 1000 V with a minimum of 1500 V ac for higher supply voltages, 48 Hz to 62 Hz, or a dc voltage equal to the ac peak voltage where an ac test voltage would damage the electronic parts within the compound.

U shall be taken as:

- the sum of the rated voltages of the two circuits being tested, for a);
- the rated voltage of the circuit being tested for b) and c).

The test voltage shall be increased steadily to the specified value in a period of not less than 10 s and then maintained for at least 60 s. No flashover or breakdown shall occur.

NOTE – Additional tests may be necessary on high voltage equipment to verify that partial discharge within the compound and corona effects do not affect the insulation properties of the compound.

8.2.4 Tests for encapsulated primary and secondary cells, batteries and accumulators

The sample shall be fitted with one or more internal temperature sensors as described in 8.2.1.

8.2.4.1 Discharge test

The sample shall be placed in an environment of T_{Amax} °C ± 2 K where T_{Amax} is the specified maximum service ambient temperature. The 2 K temperature differential criterion is used as described in 8.2.1.2.

The discharge test shall be carried out in such a manner that the fully charged encapsulated cell, battery or accumulator is completely discharged by an appropriate external load according to one of the following cases:

- 1 mΩ when the encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex components contain a current limiting resistor ~~or electronic device~~;
- a value adjusted in such a way that the current flowing is equal to 1.7 times the rated current of any encapsulated fuse;
- a value that will just not cause any encapsulated thermal protection device to operate;
- for circuits with electronic current limiting devices, the load shall be adjusted to draw maximum continuous current.

If the load is encapsulated with the cell, battery or accumulator or is fixed to the sample, it shall be considered as short circuited unless the load is not subject to fault (see 5.1.5).

The maximum temperatures of cells, batteries or accumulators and of the surface of the compound shall be measured to ensure that the requirements of 5.4 are satisfied.

The acceptance criteria are those defined in 8.2.1.3.

8.2.4.2 Dielectric strength test

The dielectric strength test of 8.2.3 shall be carried out only if the encapsulated cells, batteries or accumulators are to be used not as a sole source of power but in conjunction with other sources of power and galvanically connected to them.

9 Routine verification and routine tests

9.1 Visual check

The encapsulated electrical apparatus, encapsulated parts of electrical apparatus or the encapsulated Ex components shall be subjected to visual inspection. No visible damage of the compound shall be evident, such as cracks, exposure of the encapsulated parts, flaking, impermissible shrinkage, swelling, decomposition or softening.

9.2 Dielectric strength test

The dielectric strength test shall be carried out applying the conditions stated in 8.2.3 as follows:

- between separate circuits accessible from the outside;
- between all circuits accessible from the outside connected together and all external metal parts connected together;
- between every circuit which is accessible from the outside having an operating voltage of more than 60 V and every part accessible from the outside close to this circuit.

Optionally, the routine dielectric strength test may be carried out using a test voltage 20% higher than that specified in 8.2.3 applied for one second.

9.3 Checking the electrical data

It shall be verified that the electrical characteristics (voltage, current and active power, etc.) comply with the manufacturer's specification. ~~submitted to the national or other appropriate authority~~.

9.4 Voltage transformers

In the case of voltage transformers having voltages above 1 kV, the level of partial discharges shall be in accordance with IEC 44-4.

10 Marking

10.1 Marking of electrical apparatus

The encapsulated electrical apparatus and encapsulated parts of electrical apparatus shall carry at least the minimum marking described in ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod).

The supplementary marking specific to the type of protection encapsulation “m” prescribed in 25.2(10) of ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) is as follows:

10.1.1 The sign of the type of protection ”m”.

~~**NOTE -** This sign will be transferred in due course to IEC 79-0.~~

10.1.2 Input and output electrical data, e.g. voltage, current, etc.

10.1.3 External fuse data, in so far as it is necessary.

10.1.4 Permitted prospective short circuit current of the external electric supply source if required by 5.1.3. ~~different from 4000 A (see 5.1.3)~~.

EXCEPTION: When permitted prospective short circuit current limit is included in the manufacturer’s literature.

10.2 Marking of Ex components

Encapsulated Ex components shall carry at least the minimum marking prescribed in 25.5 of ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) (except line 4). In addition, marking specific to the type of protection “m” is as follows:

10.2.1 The sign of the type of protection “m”.

~~**NOTE -** This sign will be transferred in due course to IEC 79-0.~~

10.2.2 Input and output electrical data, e.g. voltage, current, etc.

10.2.3 External fuse data, in so far as it is necessary.

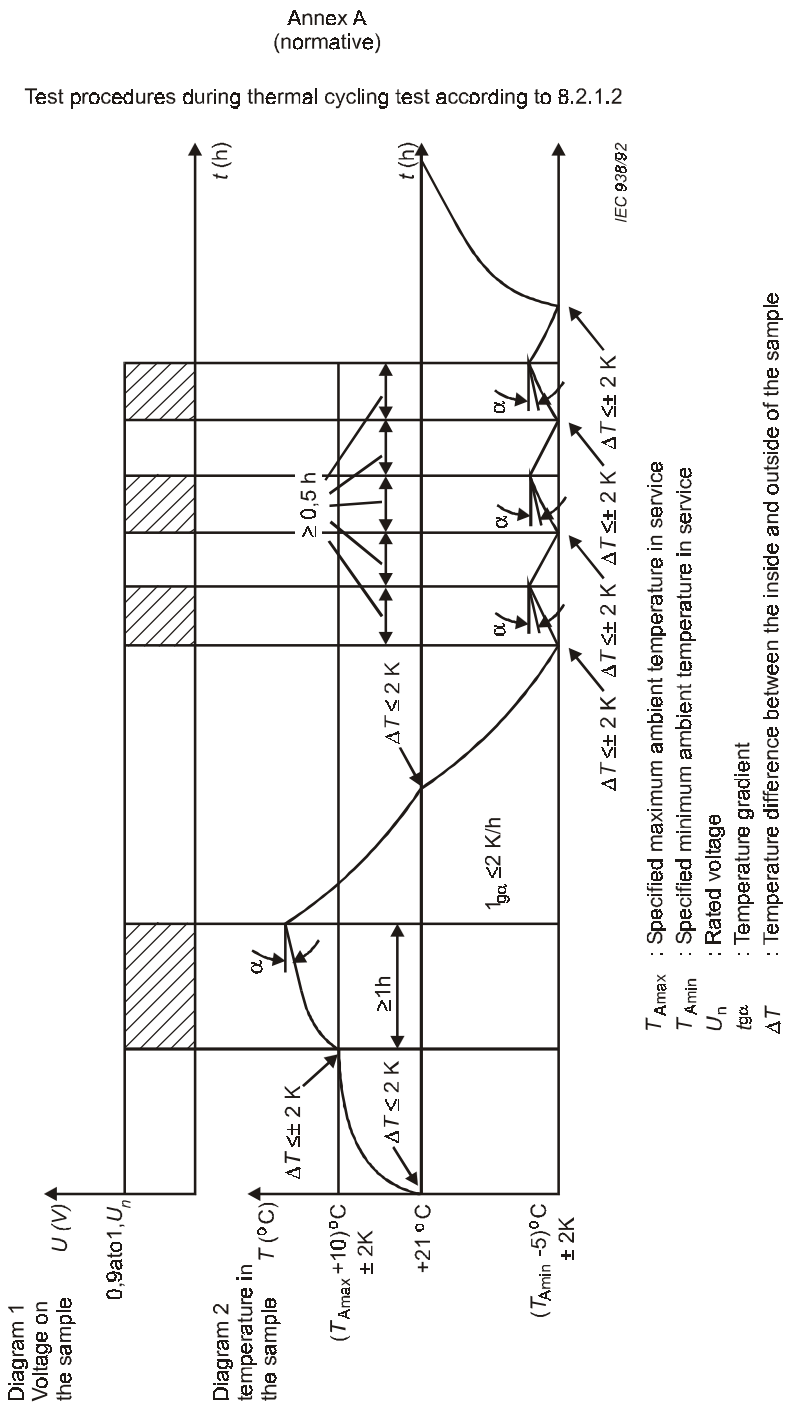
10.2.4 Permitted prospective short circuit current of the external electric supply source if required by 5.1.3. ~~different from 4000 A (see 5.1.3)~~.

EXCEPTION: When permitted prospective short circuit current limit is included in the manufacturer's literature.

~~**10.2.5**The mark "U" if appropriate.~~

~~**NOTE -** This sign will be transferred in due course to IEC 79-0~~

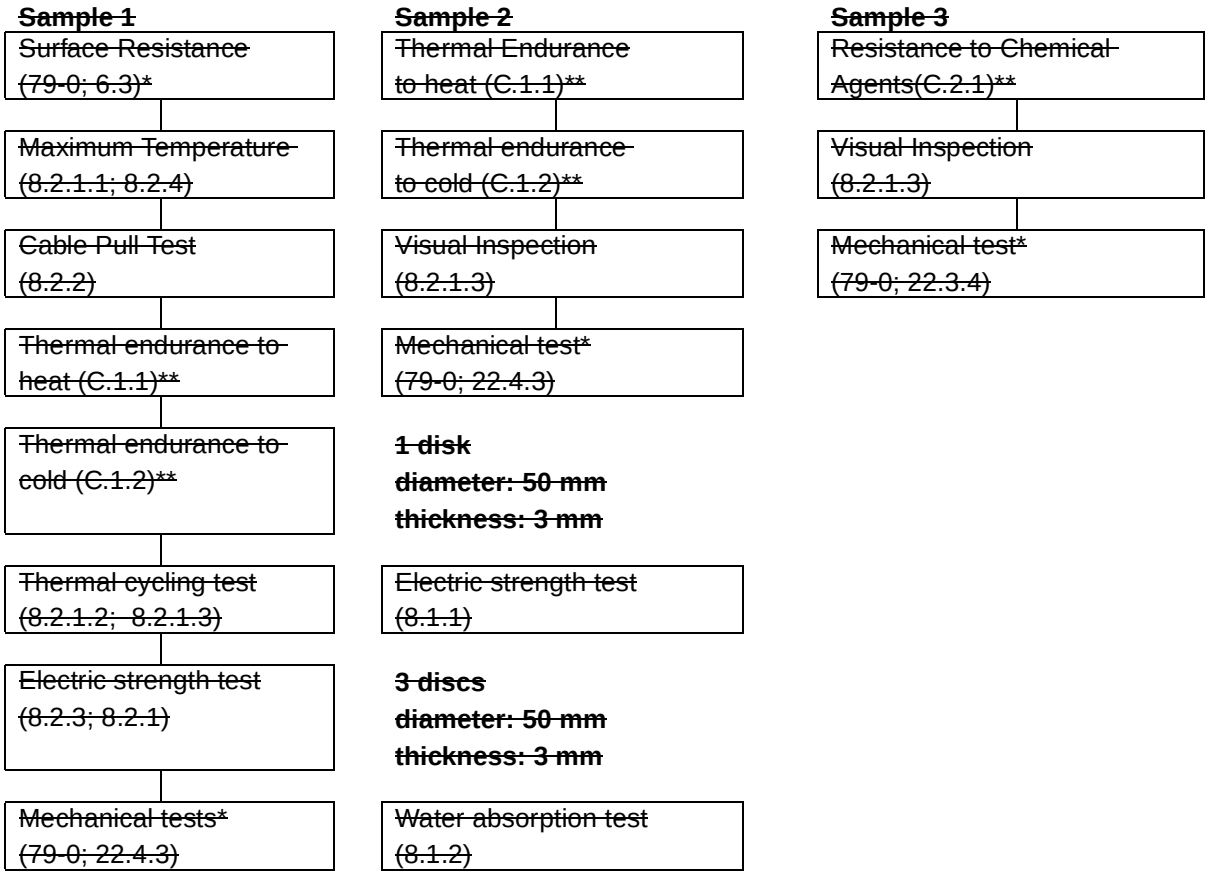
Annex A (normative)



Annex B (normative)

Sequence of tests for electrical apparatus with type of protection encapsulation “m”

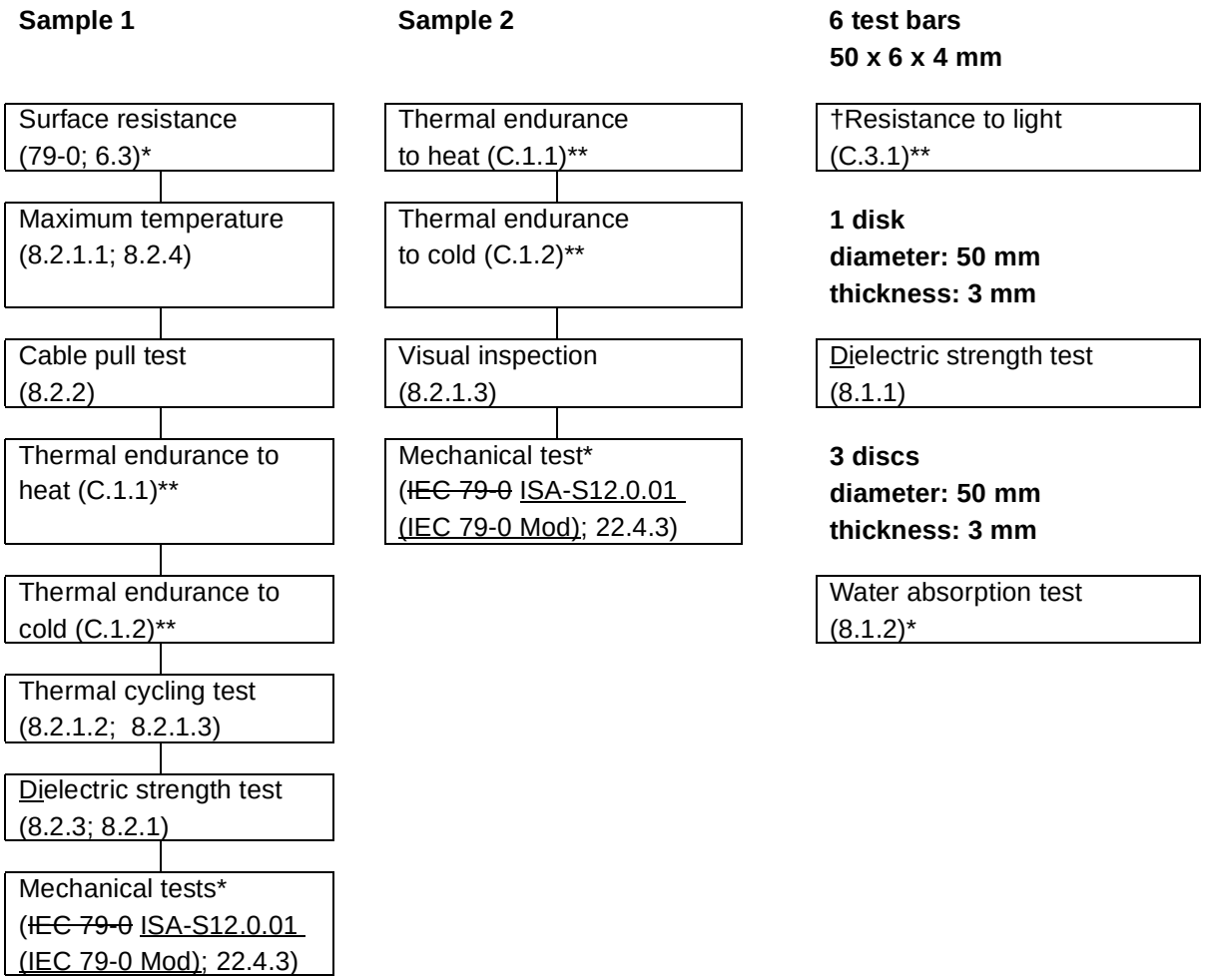
~~B.1 Sequence of tests for Group I apparatus and compounds~~



~~*~~ ~~Except for apparatus and components not freely exposed to the environment. In case where this test has not been performed, the apparatus shall be marked “X” and the associated documentation shall indicate the restrictions of use.~~

~~**~~ ~~These tests include no evaluation criteria but they prepare the samples for the following tests in the sequence.~~

B.2 Sequence of tests for ~~group II~~ apparatus and compounds



* Except for apparatus and components not freely exposed to the environment. In cases where this test has not been performed, the ~~apparatus shall be marked "X" and the associated~~ manufacturer's product documentation shall indicate the restrictions of use.

** These tests include no evaluation criteria but they prepare the samples for the following tests in the sequence.

† This test is not to be carried out on materials protected from light.

Annex C (normative)

NOTE— Sections C.1, C.2, and C.3 below are included only for the preparation of the samples referred to in Section B.2. Refer to ISA-dS12.0.01 (IEC 79-0 Mod) Section 22.4.6.2 for thermal stability testing of plastics enclosures.

Non-specific tests for the type of protection encapsulation “m”

C.1 Tests for ~~group I and group II~~ apparatus

C.1.1 Thermal endurance to heat

The thermal endurance to heat is determined by submitting the samples to continuous storage for four weeks in an environment of 90 percent to 95 percent relative humidity and at a temperature of 20 K to 22 K above the maximum service temperature but at least 80°C.

In the case of a maximum service temperature above 75° C the period of four weeks specified above will be replaced by a period of two weeks at 90° C to 97° C and 90 percent to 95 percent relative humidity followed by a period of two weeks at a temperature of 20 K to 22 K higher than the maximum service temperature.

C.1.2 Thermal endurance to cold

The thermal endurance to cold is determined by submitting the samples to storage for 24 h in an environment corresponding to the minimum service temperature reduced by at least 5K but at most 10K.

~~C.2 Test for group I apparatus~~

~~C.2.1 Resistance to chemical agents~~

~~The samples shall be submitted to the tests of resistance to the following chemical agents:~~

- ~~-oil and greases;~~
- ~~-hydraulic liquids for mining applications.~~

~~The relevant tests shall be made on two samples:~~

- ~~one sample shall remain for 24 h in oil No. 2 according to the annex “Reference immersion liquids” of ISO Standard 1817, at a temperature of 50° C.;~~

- ~~the other sample shall remain for 24 h to 26 h in a hydraulic liquid of aqueous solution of polymer in 35% water.~~

~~At the end of the test the samples concerned shall be removed from the liquid bath, carefully wiped and then stored for 24 h in the laboratory atmosphere.~~

C.3 Test for ~~group II~~ apparatus

C.3.1 Resistance to light

A test of resistance of the material to light shall be made by one of the methods below if the surface is not protected from light.

a) The test shall be carried out on six test bars in accordance with Section 61 of ANSI/UL 746C.

b) The test shall be made on six test bars of standard size (50 x 6 x 4) mm according to ISO 179. The test bars are to be made under the same conditions as those used for the manufacture of the apparatus concerned; these conditions are to be stated in the test report on the electrical apparatus.

The test shall be made in accordance with ISO 4892 in an exposure chamber using a xenon lamp and a sunlight simulating filter system, at a black panel temperature of 55° C to 58° C. The exposure time shall be 1000 h. The evaluation criterion is the impact bending strength in accordance with ISO 179. The impact bending strength following exposure in the case of an impact on the exposed side shall be at least 50 % of the corresponding value measured on the unexposed test pieces. For materials for which impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more than three of the exposed test bars may break.

Annex D (informative)—United States Major Deviations

The text of Annex D has been added. The underlining has been omitted for clarity.

General. Group I is excluded from the scope of this document and all associated text has been deleted.

General. All text has been deleted that implied a requirement for third party certification.

General. IEC references have been replaced with equivalent U.S. standards references where possible.

3.8 The definition of “Ex Component” has been moved to ISA-S12.0.01 (IEC 79-0 Mod).

5.1.2 The original allowance of up to 100 cc of encapsulated free volume has been reduced to 10 cc. The subcommittee believes that the lower value is much more realistic considering that the concept of encapsulation is not intended to seal the internal encapsulated volume from the external atmosphere, which is assumed to be flammable.

5.1.3 The prospective short circuit current value has been reduced from 4000 A to a more realistic 1500 A. This is in line with current international standards.

5.2.3 Requirements for non-metallic enclosures are included in ISA-S12.0.01 (IEC 79-0 Mod) and, therefore, are not necessary in this standard. Where a protective housing directly supports bare live parts, several different protection techniques are possible. The standard for the protection employed will specify the creepage and clearance requirements if any.

6.1 (2) and (3) added to clarify and further specify the requirements for cells, batteries, and accumulators in encapsulated apparatus.

6.2 Fuse requirements brought into line with current U.S. standards and practices.

8.2.4.1 Requirements added for encapsulated apparatus protected by electronic current-limiting devices.

9.2 One second duration dielectric test added to reflect current U.S. standards and practices.

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