

Standard

**Electrical Apparatus
for Use in Class I, Zones 0 & 1
Hazardous (Classified) Locations
*General Requirements***



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-S12.0.01 (IEC 79-0 Mod)—Electrical Apparatus for Use in Class I, Zones 0 & 1 Hazardous (Classified) Locations—General Requirements

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Preface

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Foreword

All text of IEC 79-0:1983, including Amendments 1 and 2, is included. U.S. National Deviations are shown by ~~strikeout~~ through text deleted and underline under text added. Tables, or portions of tables, that are to be deleted are shown as shaded; figures to be deleted are marked with the overlay "Figure X Deleted." All added tables are numbered by a Table number corresponding to the applicable Sub-clause for improved clarity and are NOT underlined. Notes appear in the table titles showing the tables as added material. There are four Annexes in this Standard. The Annexes are informative and are not considered part of this Standard.

1 Scope

1.1 This standard specifies the general requirements for construction, testing and marking of electrical apparatus for Class I, Zones 0 & 1 explosive gas atmospheres and is supplemented or modified by the following ~~parts of IEC Publication 79 standards~~ concerning specific types of protection:

- Flameproof Enclosures "d" (~~Publication 79-1~~) (ISA-S12.22.01 (IEC 79-1 Mod))
- ~~Pressurized Enclosures (Publication 79-2)~~
- Powder-filling "q" ~~Sand-filled Apparatus (Publication 79-5)~~ (ISA-S12.25.01 (IEC 79-5 Mod))
- Oil-immersion "o" ~~Oil-immersed Apparatus (Publication 79-6)~~ (ISA-S12.26.01 (IEC 79-6 Mod))
- Increased Safety "e" (~~Publication 79-7~~) (ISA-S12.16.01 (IEC 79-7 Mod))
- Intrinsic Safety "i" (~~Publication 79-11~~) (ISA-dS12.2.01 (IEC 79-11 Mod))
- Encapsulation "m" (ISA-S12.23.01 (IEC 79-18 Mod))

NOTE – The protection technique of pressurization has not been included as the present ANSI Standard for this protection technique does not include requirements for Zones. It is anticipated that this protection technique could be added to this document if the standard is developed.

~~Note: – In order to permit new developments it is recommended that apparatus which does not comply with the requirements of IEC Publication 79 but is recognized as safe for use in explosive gas atmospheres by a national or other appropriate authority should be marked with the symbol 's' (See Clause 25). Such apparatus may be part of apparatus that complies with the requirements of IEC Publication 79.~~

1.2 This standard is applicable to electrical apparatus for explosive gas atmospheres where atmospheric conditions for the explosion characteristics of the explosive gas atmosphere are considered as having pressures in the range 80 kPa (0.8 bar) to 110 kPa (1.1 bar) at a temperature in the range from -20°C to ~~+60°C~~ 40°C. Atmospheric conditions outside this range may need special consideration.

1.3 This standard is not applicable to devices whose electrical parameters, according to the manufacturer's specifications, do not exceed any of the values 1.2 V, 0.1 A, 20µJ, or 25 mW, which need not be certified or marked as required by ~~IEC Publication 79~~ applicable Standards for Class I, Zones 0 & 1. However, such devices are subject to the requirements of the ~~various parts of IEC Publication 79~~ standards as specified in Sub-clause 1.1 if they are connected to a device which contains a source or a storage element of electrical energy which could cause the circuit to exceed these parameters.

1.4 Apparatus covered by this standard and the associated standards noted in 1.1 shall also comply with the applicable requirements for similar apparatus for use in unclassified locations.

NOTE – Requirements for electrical safety in ordinary (unclassified) locations can be found in ANSI Standards, NEMA Standards, Federal Regulations, etc.

2 Definitions

For the purpose of this standard, the following definitions apply:

2.1 electrical apparatus: All items applied as a whole or in part for the utilization of electrical energy such as items for the generation, transmission, distribution, storage, measurement, regulation, conversion, and consumption of electrical energy and items for telecommunication.

2.2 explosive gas atmosphere: A mixture with air, under atmospheric conditions¹, of flammable substances in the form of gas, vapor, or mist in which, after ignition, combustion spreads throughout the unconsumed mixture.

2.3 hazardous area: An area in which an explosive gas atmosphere is, or may be expected to be, present in a quantity such as to require special precautions for the construction, installation, and use of electrical apparatus.

2.4 electrical apparatus for explosive gas atmospheres: Electrical apparatus in conformity with one or more parts of IEC Publication 79 applicable ISA Standards for Class I, Zones 0 & 1.

NOTE – The terms "explosion-protected electrical apparatus" and "hazardous (classified) location electrical equipment" are also used in some countries.

2.5 explosive test mixture: A specified explosive mixture used for the testing of electrical apparatus for explosive gas atmospheres.

2.6 ignition temperature of an explosive gas atmosphere: The lowest temperature of a heated surface at which, under specified conditions according to IEC Publication 79-4: Electrical Apparatus for Explosive Gas Atmospheres, Part 4: Method of Test for Ignition Temperature, the ignition of a flammable substance in the form of a gas or vapor mixture with air will occur.

2.7 maximum surface temperature: The highest temperature which is attained in service under the most adverse conditions (but within the tolerances) by any part or surface of an electrical apparatus which would be able to produce an ignition of the surrounding atmosphere.

NOTE – The most adverse conditions include recognized overloads and any fault condition recognized in the specific standard for the type of protection concerned.

2.8 type of protection: The specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive gas atmosphere.

2.9 degree of protection provided by enclosures: The measures applied to enclosures of electrical apparatus to provide for:

- 1) the protection of persons against contact with or approach to live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure and protection of the apparatus against ingress of solid foreign bodies;

¹ [See Scope](#)

2) the protection of the apparatus inside the enclosure against harmful ingress of water.

2.10 cable entry: A device permitting the introduction of an electric cable into an electrical apparatus.

2.11 conduit entry: A means of introducing a conduit into an electrical apparatus.

2.12 enclosure: All the walls which surround the live parts of electrical apparatus including doors, covers, cable entries, rods, spindles and shafts, ensuring the protection of the electrical apparatus.

2.13 connection facilities: Terminals, screws, and other parts used for the electrical connection of conductors of external circuits.

2.14 terminal compartment: A separate compartment or part of a main enclosure, communicating or not with the main enclosure, and containing connection facilities.

2.15 luminaire: The international term for a lighting fixture defined as a complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

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

3 Grouping and classification of electrical apparatus

3.1 Electrical apparatus for explosive gas atmospheres is divided into:

Group I: electrical apparatus for mines susceptible to fire-damp; (Group I apparatus is not within the scope of this modified document).

Group II: electrical apparatus for all places with an explosive gas atmosphere, other than mines susceptible to fire-damp.

~~For mines where gases other than fire-damp may normally and naturally occur, the electrical apparatus shall be constructed in accordance with Group I requirements, but shall also be~~

~~submitted to the tests prescribed for the appropriate Group II explosive mixture and marked accordingly.~~

3.2 Electrical apparatus of Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended.

3.2.1 For certain types of protection, the subdivision A, B, or C is prescribed; this is based on the maximum experimental safe gap (MESG) for flameproof enclosures or on minimum igniting current (MIC) for intrinsically safe electrical apparatus (see IEC Publication 79-12: Electrical Apparatus for Explosive Gas Atmospheres, Part 12: Classification of Mixtures of Gases or Vapors with Air According to their Maximum Experimental Safe Gaps and Minimum Igniting Currents). A comparison of IEC and National Electrical Code ANSI/NFPA 70 (NEC) Gas Groups is shown in Table 3.2.1.

NOTE – Apparatus marked IIB is suitable for applications requiring Group IIA apparatus. Similarly, apparatus marked IIC is suitable for applications requiring Group IIA and Group IIB apparatus.

Table 3.2.1
Approximate Comparison of IEC Apparatus and NEC Gas Groups
This table is added material.

IEC Group Designation NEC - Article 505 Group Designation	NEC - Article 500 Group Designation	Typical Gas
IIC	A	Acetylene
(IIB + H ₂)*	B	Hydrogen
IIB	C	Ethylene
IIA	D	Propane

*** Note** — (IIB + H₂) is not an IEC / NEC Apparatus / Gas Group. As Type of Protection flameproof “d” does not permit the use of flange joint apparatus in atmospheres containing Acetylene; this designation is commonly used for such apparatus to designate that it can be used in Group IIB atmospheres and Hydrogen atmospheres. This is generally representative of IIC atmospheres that do not include Acetylene.

3.2.2 For all types of protection, the temperature classes T1 to T6 correspond to the classification of electrical apparatus according to its maximum surface temperature.

3.3 Electrical apparatus may be tested for a particular explosive gas atmosphere. In this case it shall be certified and marked accordingly.

NOTE – For additional descriptive information on the "Zone" classification system and its relationship to the "Division" classification system, see ISA S12.1.01.

4 Temperatures

4.1 Electrical apparatus for explosive gas atmospheres shall normally be designed for operation in an ambient temperature range from - 20 °C to + 40 °C. Where the electrical apparatus is suitable for a temperature range which differs from this range, it shall be marked accordingly. The temperature classification, "T" class as given in Table I, shall be based on the maximum temperature of the ambient temperature range for which the apparatus is designed.

4.2 The maximum surface temperature shall not exceed:

- ~~for Group I electrical apparatus:
150 °C where coal dust can form a layer;
450 °C if the above risk is avoided.~~
- for Group II electrical apparatus:
the value in Table I which corresponds to the temperature class of the electrical apparatus.

NOTE — ~~When choosing electrical apparatus of Group II, the user should take into account the influence and the smoldering temperature of dusts if they are likely to be deposited in a layer.~~

Table I
Classification of maximum surface temperatures for Group II electrical apparatus

Temperature class	T1	T2	T3	T4	T5	T6
Maximum surface temperature (°C)	450	300	200	135	100	85

4.3 For Group II electrical apparatus, if a maximum surface temperature different from those in Table I is selected, this temperature shall be indicated on the electrical apparatus concerned.

4.4 The maximum surface temperature of the electrical apparatus shall be below the lowest ignition temperature of the explosive gas atmospheres for which the electrical apparatus is designed. However, for components having a total surface area of not more than 10 cm² (e.g. transistors or resistors used in intrinsically safe electrical circuits), their surface temperature may exceed that for the temperature class marked on the electrical apparatus if there is no direct or indirect risk of ignition from these components with a safety margin of:

50 K for T1, T2 and T3
25 K for T4, T5 and T6

This safety margin shall be ensured by experience of similar components or by test of the electrical apparatus itself in explosive mixtures having the appropriate thermal ignition characteristics.

NOTE – During the test, the safety margin may be verified by increasing the ambient temperature.

5 General

5.1 Electrical apparatus for Class I, Zones 0 & 1 explosive gas atmospheres shall be suitable for industrial use and shall comply with the requirements of this standard except where these requirements are modified by the ~~part of IEC Publication 79~~ standards in [Sub-clause 1.1](#) specific to the type of protection concerned.

NOTE – If the electrical apparatus is to withstand particularly adverse service conditions (e.g. mechanical, electrical, thermal and chemical effects) these should be specified by the user, and the appropriate measures should be agreed between manufacturer and user.

~~The manufacturer indicates under his own responsibility that the apparatus is suitable for industrial use. This is not subject to confirmation by the national or other appropriate authority.~~

5.2 Enclosures for electrical apparatus which may be opened more quickly than the time necessary:

a) for the discharge of incorporated capacitors to a residual energy of:

0.2 mJ for electrical Apparatus of Group I ~~and~~ IIA, or

0.06 mJ for electrical apparatus of Group IIB, or

0.02 mJ for electrical apparatus of Group IIC, or

b) for the cooling of enclosed components to a temperature below the temperature class of the electrical apparatus,

shall be provided with a label stating:

1) the delay required before attempting to open the enclosure, or

2) that the enclosure is not to be opened when a flammable atmosphere is present.

5.3 Where drainage devices are provided in electrical apparatus, they shall comply with the requirements of this standard and those of the ~~part of IEC Publication 79~~ standards as specified in Sub-clause 1.1 specific to the type of protection concerned.

6 Enclosures of plastics material

6.1 Enclosures of plastics material shall be thermally stable. The relevant type tests are specified in [Sub-clause 22.4.6.2](#).

6.2 Threaded holes in enclosures for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons shall be one of the following types:

- a) Tapped metal inserts for metal fasteners. The inserts shall be permanently fixed in the plastics material of the enclosure.
- b) Tapped holes in plastics enclosures for metal fasteners. The thread form shall be compatible with the plastics material.
- c) Tapped holes in plastics enclosures for plastics fasteners. The thread form and the plastics materials shall be compatible and of adequate strength and durability.

6.3 The requirements of this Sub-clause together with those in [Sub-clause 22.4.7](#) apply to plastics enclosures, to plastics parts of enclosures, and to other exposed plastics parts of electrical apparatus, except for plastics accessories such as sealing rings of cable entries, insulation of plugs and sockets, insulation of bushings and sealing gaskets on which the type of protection does not depend.

Plastics enclosures for non-fixed electrical apparatus and fixed apparatus with plastics parts that are likely to be rubbed or cleaned on site shall be so designed that, under normal conditions of use, maintenance, and cleaning, danger of ignition due to electrostatic charges is avoided:

- by virtue of the size, shape and layout, or other protective methods, so that dangerous electrostatic charges are not likely to occur.
- or by suitable selection of the plastics material so that the insulation resistance, measured according to the method given in Sub-clause 22.4.7, does not exceed $1\text{G } \Omega$ ([see Note 1](#)).

- or by limitation of the surface area of plastics enclosures or plastics parts of enclosures as follows (see also Note 2):
 - a) ~~for Group I apparatus to a maximum of 100 cm²;~~
 - b) for Group IIA and IIB apparatus to a maximum of 100 cm², except that this may be increased to a maximum of 400 cm² if the exposed areas of plastics are surrounded by conductive earthed (grounded) frames;
 - c) for Group IIC apparatus, including light transmitting parts, to a maximum of 20 cm² except that this may be increased to a maximum of 100 cm² if the plastics parts are additionally protected against the occurrence of dangerous electrostatic charges.

If the danger of ignition has not been avoided in the design, a warning label shall indicate the safety measures to be applied in service.

NOTES:

- 1) When selecting electrical insulating materials, attention should be paid to maintaining a minimum insulation resistance to avoid problems arising from touching exposed plastics parts that are in contact with live parts.
- 2) Further restrictions may apply to plastics enclosures for use in areas where an explosive gas atmosphere is present continuously or is present for long periods (Zone 0).

7 Light-alloy (e.g., aluminum, beryllium, titanium) enclosures

There are no requirements at present for light-alloy enclosures.

NOTE – ~~Some countries do not permit the use of some light alloys in mines susceptible to fire-damp.~~

8 Fasteners

8.1 General

Parts necessary to achieve a standard type of protection or used to prevent access to uninsulated live parts, shall be capable of being released or removed only with the aid of a tool.

Fastening screws for light-alloy enclosures may be made of light alloy or other materials if the material of the fasteners is compatible with that of the enclosure.

Threaded holes in enclosures for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons may be tapped in the light alloy only when the thread-form is compatible with the material of the enclosure.

8.2 Special fasteners

~~When any part of IEC Publication 79 requires a special fastener, this shall be a fastener which requires the use of a special tool for its removal.~~

~~This may be achieved, for example, by the use of:~~

~~unslotted hexagon screws or bolts conforming to ISO Standards 262 and 272 with standard head,~~

~~or~~

~~hexagon nuts conforming to ISO Standards 262 and 272 (standard head) fitting on threaded studs conforming to ISO Standard 262,~~

~~or~~

~~hexagon socket head cap screws conforming to ISO Standards 262 and 4762, and~~

~~a protective shroud or a counterbored hole enclosing each screw head or nut over its full height and at least two-thirds round its periphery. If shrouds are used they shall be either:~~

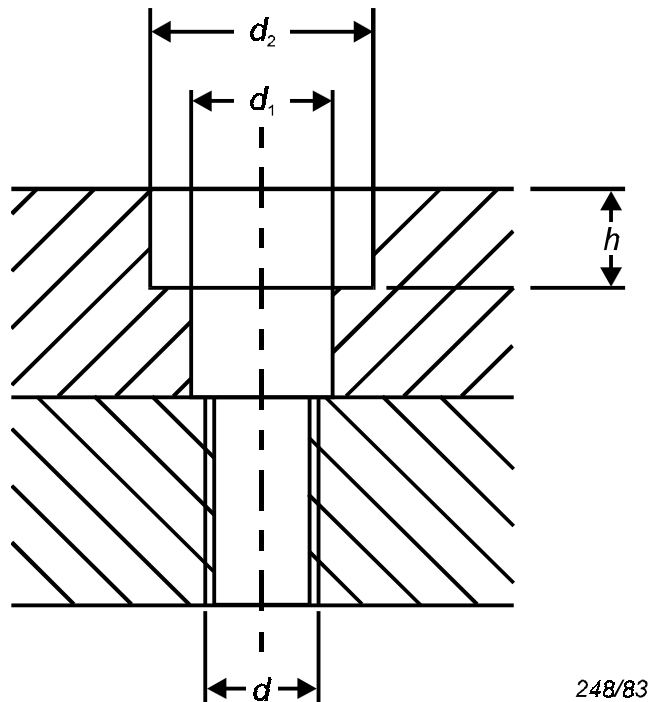
- ~~a) integral with the enclosure, or~~
- ~~b) attached to the enclosure and firmly secured to it, or~~
- ~~c) so fixed to one another that they can neither turn nor be removed.~~

~~For the examples above, the dimensions of the screws and of the protective shrouds or counterbored holes are given in Table II.~~

TABLE II**Dimensions of special fasteners described in Sub-clause 8.2**

Nominal diameter		Protective shroud or counterbored holes				
of thread d	Of hole d_1 (mm)	h (mm)	Normal d_2 (mm)		Reduced d_2 (mm)	
6 H ISO 965	H 13 ISO/R 286	min.	min.	max.	min.	max.
M4	4.5	4	-	-	8	9
M5	5.5	5	17	19	10	11
M6	6.6	6	18	20	11	12
M8	9	8	22	25	15	16
M10	11	10	27	30	18	20
M12	14	12	31	35	20	22
M14	16	14	36	40	24	26
M16	18	16	40	44	26	28
M20	22	20	46	50	33	35
M24	26	24	57	61	40	42
NOTE – Hexagonal-headed screws and nuts with nominal thread diameter M5 should be avoided.						

FIGURE DELETED



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Either the normal or the reduced diameter of shroud or counterbore may be used except where particular restrictions are specified in the IEC publication for the specific type of protection of the electrical apparatus.

Screws, bolts and nuts above M16 (Group II) and M24 (Group I) need not be protected by shrouds or counterbored holes.

9 Interlocking devices

Interlocking devices used to maintain a type of protection shall be so constructed that their effectiveness cannot readily be defeated by the use of normally available tools.

10 Bushings and terminal studs

Bushings and terminal studs used as connection facilities and which may be subjected to a torque while the connection is being made shall be mounted in such a way that they are secured against turning.

The relevant type tests are specified in [Sub-clause 22.4.5](#).

11 Cementing and sealing materials

Materials, such as those used for cementing windows and sealing compounds, but excluding gaskets, shall be chemically stable, inert and resistant to external influences (for example, water, oil and solvents), or else be effectively protected against these influences. They shall have a permanent thermal stability adequate for the temperatures to which they will be subjected within the rating of the electrical apparatus.

The thermal stability shall be considered to be adequate if the material is stable at the two following temperatures:

- the lowest temperature to which it will be subjected;
- 20 K above the highest temperature to which it will be subjected, or 120 °C, whichever value is the greater.

12 Connections

Contact pressure of electrical connections shall not be affected by dimensional changes in service (due to temperature, humidity, etc.) of insulating materials.

13 Connection facilities for earthing (equipment grounding) or equipotential bonding conductors

13.1 A terminal or other facility for the connection of an earthing or equipotential bonding (equipment grounding) conductor shall be provided inside the terminal compartment of electrical apparatus and near the other connection facilities.

13.2 Electrical apparatus with a metallic enclosure shall have an additional external connection facility for an earthing or equipotential bonding conductor. The external connection facility is not required for electrical apparatus which can be moved when energized and is supplied by a cable incorporating an earthing or bonding conductor.

13.3 Neither an internal nor external earthing or bonding connection facility is required for electrical apparatus for which earthing is not required, such as double insulated electrical apparatus, or for which supplementary earthing is not necessary, such as apparatus with metallic enclosures used with conduit systems.

13.4 Earthing or equipotential bonding (equipment grounding) conductor connection facilities inside terminal compartments shall be suitable for the effective connection of at least one conductor with a cross-sectional area as specified in IEC Publication 364-5-54: Electrical Installations of Buildings, Chapter 54: Earthing Arrangements and Protective Conductors. ANSI/NFPA-70, National Electrical Code - Article 250-95.

13.5 Earthing or equipotential bonding connection facilities on the outside of enclosures shall allow the effective connection of conductors as specified in IEC Publication 364-5-54 with a minimum of 4 mm².

13.6 To ensure good electrical contact, these connection facilities shall be effectively protected against corrosion. They shall also be designed so that the conductors are secured against loosening and twisting and so that contact pressure is maintained.

Special precautions to prevent corrosion shall be taken, if necessary, if one of the contact parts consists of light alloy.

14 Connection facilities and terminal compartments

14.1 Electrical apparatus which is intended for connection to external circuits shall include connection facilities except for electrical apparatus which is manufactured with a cable permanently connected to it.

14.2 Terminal compartments and their access openings shall be designed so that the conductors can be readily connected.

14.3 Terminal compartments shall comply with one of the ~~parts of IEC Publication 79 standards~~ as specified in Sub-clause 1.1 specific to standard types of protection.

14.4 Terminal compartments shall be so designed that, after proper connection of the conductors, the clearances and creepage distances comply with the requirements, if any, of the ~~part of IEC Publication 79 standards~~ as specified in Sub-clause 1.1 specific to the type of protection concerned.

15 Cable and conduit entries

15.1 Cable and conduit entries shall be constructed and mounted so that they do not alter the specific characteristics of the type of protection of the electrical apparatus on which they are mounted. This shall apply to the whole range of cable diameters specified by the manufacturer of the cable entries as suitable for use with those entries.

Sealing of cable entries shall be ensured by use of one of the following means (~~see Figure 1~~):

- an elastomeric sealing ring, or
- hard setting resin or compound, or
- a metallic sealing ring (e.g., in the case of metal clad ~~sheathed~~ cable), or
- ~~asbestos or asbestos rope~~ suitable flame resistant packing.

- 1 = Branching point of the conductors
- 2 = Sealing ring
- 3 = Cable entry body
- 4 = Clamping ring with curved rim
- 5 = Cable

FIGURE DELETED

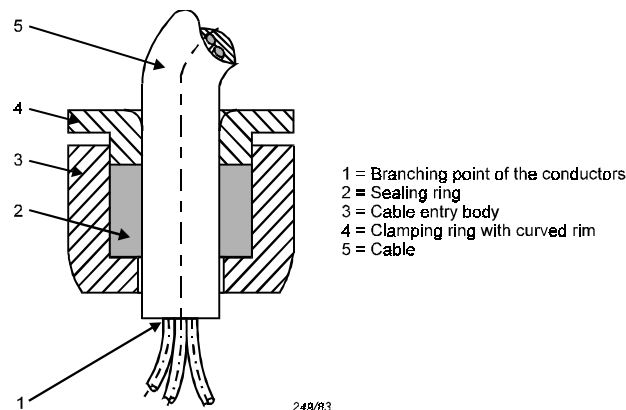


Figure 1. — Illustration of the terms used for cable entries using a sealing ring.

The cable entries shall ensure:

- a) the passage of the cable through the enclosure wall without damage to the cable, and
- b) if necessary, clamping of the cable and the bonding of the metal armoring, sheath or screen.

15.2 The cable entries shall produce an effective clamping of the cable in order to prevent pulling or twisting applied to the cable being transmitted to the connections. They shall comply with the tests prescribed in [Sub-clauses 22.4.9](#) or [22.4.10](#).

~~These requirements do not apply to cable entries of Group II fixed electrical apparatus for which the clamping of the cable can be effected elsewhere.~~

~~Notes 1. A cable entry with sealing ring can ensure effective clamping of unarmored cables.~~

~~2. Additional clamping means, other than the seal, may be required for cable entries for non-fixed apparatus.~~

15.3 The entries for flexible cables shall have no sharp edges capable of damaging the cable when it is moved through an angle of 90° in any direction with respect to the axis of the entry. The entry point shall be rounded so that the radius of curvature of the cable cannot be less than a quarter of the diameter of the maximum size cable allowed for the entry.

15.4 Entry by conduit may be by screwing into threaded holes or locking in plain holes:

- in the wall of the enclosure, or
- in an adapter plate designed to be fitted in or on the walls of the enclosure, or
- into a suitable ~~stopping box~~ conduit seal, integral with or attached to the wall of the enclosure.

NOTE – Installation documents, e.g., ANSI/NFPA 70, may require grounding type devices when installing conduit in plain holes of metal enclosures.

15.5 Openings in the walls of electrical apparatus which are intended for cable or conduit entries shall be designed so that, if an entry is not used, the corresponding opening can be closed by a blanking element in such a way that the requirements of the ~~part of IEC Publication 79~~ standards as specified in Sub-clause 1.1 specific to the type of protection of the electrical apparatus and the degree of protection are satisfied.

The means provided for this shall be such that the blanking element can be removed only with the aid of a tool.

15.6 In exceptional cases when the conductor temperature under rated conditions exceeds ~~70~~ 60 °C at the cable or conduit entry point, or 60 °C at the branching point of the conductors, a label shall be provided on the inside or outside of the electrical apparatus as a guide for the selection by the user of the cable, or of the wiring in the conduit.

NOTE – Acceptable wiring methods are given in installation documents – e.g., ANSI/NFPA 70 - Article 505.

16 Rotating electrical machines

16.1 Ventilation openings for external fans

The degree of protection of ventilation openings for external fans of rotating electrical machines shall be at least:

- IP20 on the air inlet side,
- IP10 on the air outlet side,

according to IEC Publication 34-5: Rotating Electrical Machines, Part 5: Classification of Degrees of Protection Provided by Enclosures for Rotating Machines.

For vertical rotating electrical machines, foreign bodies shall be prevented from falling vertically into the ventilation openings.

~~**For Group I rotating electrical machines, the degree of protection IP10 is adequate only when the openings are designed or arranged so that foreign bodies with dimensions above 12 mm cannot be carried on to the moving parts of the machine, either by falling vertically or by vibration.**~~

16.2 Construction and mounting of ventilating systems

Fans, fanhoods, ventilation screens, etc., shall be of robust construction and fixed so as to prevent distortion and displacement which could cause impact or friction of rotating parts against the fixed parts.

16.3 Clearances for ventilating systems

In normal operation, the clearances between an external fan and the hood and ventilation screen and their fasteners shall be at least 1/100 of the maximum diameter of the fan and shall be not less than 1 mm. These clearances need not exceed 5 mm. They may be reduced to 1 mm if the opposing parts are machined.

These clearances shall be measured at rest, under the most unfavorable conditions likely to be produced by the maximum movements of parts in normal operation, and shall be carried out before mechanical testing. (See Sub-clause 22.4.3.)

16.4 Materials used for fans

The external fans of rotating electrical machines which are manufactured in plastics material shall have an electrical resistance, as measured according to the method specified in Sub-clause 22.4.7, not exceeding 1 G-ohm except for Group II machines, the fans of which have a peripheral speed which is below 50 m/s.

NOTE – There are no requirements at present concerning the use of light alloys. ~~Some countries do not permit the use of some light alloys in mines susceptible to fire-damp.~~

17 Switchgear

17.1 Switchgear with contacts immersed in oil is not permitted for direct current.

~~Alternating current switchgear with contacts immersed in oil is not permitted for Group I electrical apparatus, where the voltage does not exceed 1100V; it is permitted above 1100V only when each pole is segregated, with an oil content of not more than 5 liters per pole.~~

17.2 Disconnectors (disconnecting means) of Group I which shall have a suitable breaking capacity (interrupting rating) ~~less than that of category AC3, as specified in IEC Publication 292-1: Low-voltage Motor Starters, Part 1: Direct-on-line (Full Voltage) A.C. Starters,~~ or shall be electrically or mechanically interlocked with a suitable load breaking device, or shall For disconnectors of Group II it is sufficient to have a label "CAUTION - DO NOT OPERATE UNDER LOAD" placed near the disconnectors.

17.3 Where switchgear includes a disconnector, the latter shall disconnect all poles and shall be designed so that the position of the disconnector contacts is visible, or their open position is reliably indicated. Interlocks, if any, between such a disconnector and the cover or door of the switchgear shall allow this cover or door to be opened only when the separation of the disconnector contacts is sufficient to disconnect the supply.

~~**17.4** The operating mechanism of disconnectors for Group I switchgear shall be capable of being padlocked in the open position.~~

~~**17.5** For Group I switchgear, short-circuit and earth fault protection relays, if used, shall latch out. The resetting device shall either have a special fastener as prescribed in Sub-clause 8.2 or shall be inside the enclosure containing the relays.~~

17.6 Covers giving access to the interior of enclosures containing remotely operated apparatus² with switching contacts shall:

- either be interlocked with a disconnector;

² In which circuits can be made or broken by a separate influence (which may be mechanical, electrical, electro-optical, acoustic, magnetic, or thermal) when this influence is not applied manually to the apparatus itself.

- or bear a label saying, "CAUTION - DO NOT OPEN WHEN ENERGIZED," unless parts which remain energized after opening these covers are protected by a standard type of protection. Where type of protection "e" is used, the degree of protection may be reduced to IP20.

18 Fuses

Enclosures containing fuses shall be interlocked so that insertion or removal of fuse links can be carried out only with the voltage off and so that the fuse cannot be energized until the enclosure is correctly closed.

An interlock is not required if a label "CAUTION - DO NOT OPEN WHEN ENERGIZED" is fixed on the enclosure of the apparatus.

19 Plugs and sockets

Plugs and sockets shall be interlocked mechanically or electrically so that they cannot be separated when the contacts are energized and so that the contacts cannot be energized when the plug and socket are separated.

~~Alternatively, plugs and sockets which are not interlocked as indicated above shall be fixed together by means of the special fasteners defined in Sub-clause 8.2 and shall bear a label reading "DO NOT SEPARATE WHEN ENERGIZED".~~

Plugs with components which can remain energized when not engaged with a socket are not permitted.

For Group II apparatus, plug and socket assemblies which are designed to break the full-rated current with delayed release to permit the arc to be extinguished before separation, and which remain flameproof during the arc quenching period, and with a cover providing a degree of protection of IP43 (or Type 3, 3S, 4, 4X, 6, or 6P in accordance with ANSI/UL 50 Enclosures for Electrical Equipment) for the exposed socket outlet, need not comply with the requirements of this clause.

NOTE – Refer to Sub-clause 22.4.4 for tests for degree of protection.

20 Luminaires

20.1 The source of light of luminaires shall be protected by a light-transmitting cover and may also be protected by a guard. These shall be capable of passing the tests prescribed in [Sub-clause 22.4.3.1](#).

20.2 All luminaires shall have a label reading "CAUTION- DO NOT OPEN WHEN ENERGIZED" unless they are fitted with a device which automatically isolates all poles of the luminaire lampholders.

20.3 Lamps containing free metallic sodium, for example, low pressure sodium lamps in accordance with IEC 192 and its amendment No. 2, are not permissible. High pressure sodium lamps, for example, lamps in accordance with IEC 662, may be used.

21 Hand lamps and cap lamps

21.1 The materials used for hand lamps and cap lamps shall be chemically resistive to the electrolyte of the source of supply. Leakage of the electrolyte shall be prevented in all positions of the apparatus.

21.2 Where the source of light and source of supply are housed in separate enclosures, the cable entries and the connecting cable shall withstand a tensile load of 150 N ~~with no reduction in their security against explosions~~. The connecting cable shall be ~~covered with a sheath material which is oil resistant and difficult to ignite~~ oil-resistant, (e.g., SO, STO), and approved for extra hard usage.

~~**Note.** --- Verifications and tests on modified or repaired electrical apparatus. Modifications made on the electrical apparatus affecting the type of protection or the temperature of the apparatus are permitted only if the modified apparatus is resubmitted to a national or other appropriate authority.~~

~~In the case of repairs to electrical apparatus affecting the type of protection, the parts which have been repaired are to be subjected to new routine verifications and tests which need not be made by the manufacturer.~~

22 Type verifications and tests

22.1 General

The type verifications and tests are intended to ensure that the requirements of this standard and those of the ~~part of IEC Publication 79~~ ISA Standards specific to the type of protection concerned have been satisfied by a prototype or sample of the electrical apparatus.

22.2 Verification of documents

~~The national or other appropriate authority shall verify that~~ Documents submitted by the manufacturer shall give a full and correct specification of the safety aspects of the electrical apparatus ([see Sub-clause 5.1](#)).

~~It shall also verify that in~~ The design of the electrical apparatus, the requirements of this standard, and those of the ~~parts of IEC Publication 79~~ ISA Standards specific to the type of protection concerned shall be ~~have been~~ observed.

22.3 Compliance of prototype or sample with documents

~~The national or other appropriate authority shall verify that~~ The prototype or sample of the electrical apparatus submitted for the type test shall comply ~~complies~~ with the manufacturer's definitive documents referred to above.

22.4 Type tests

22.4.1 General

A prototype or sample shall be tested ~~by the national or other appropriate authority~~ in accordance with the requirements for type tests of this standard and those of the ~~part of IEC Publication 79~~ standards as specified in Sub-clause 1.1 specific to the type of protection concerned.

~~However the national or other appropriate authority may omit certain tests, judged to be unnecessary, in which case the justification for such omission shall be given in the test report.~~

~~The tests are made either in the laboratory of the national or other appropriate authority or elsewhere under the supervision of that authority, for example at the manufacturer's works.~~

~~The national or other appropriate authority will, where necessary, call for modifications that it considers to be needed to bring the electrical apparatus into conformity with the requirements of this standard and with those of the part of IEC Publication 79 specific to the type of protection concerned.~~

22.4.2 Each test is to be made with the accessories (e.g., cable entries, instruments, plugs and sockets, blanking plates) provided for by the manufacturer in the descriptive documents of the electrical apparatus and the mounting of which is considered by the national or other appropriate authority to be the most unfavorable.

The test report will cover the electrical apparatus and the accessories listed in the report. The manufacturers of standardized accessories need not be identified if their design is completely defined.

22.4.3 Mechanical tests

Mechanical tests are carried out to check that the strength of apparatus is adequate.

22.4.3.1 Tests for resistance to impact

Tests for resistance to impact are applied at impact energy levels which vary according to the type of apparatus, or parts of apparatus, as shown in Table III.

Table III
Tests of resistance to impact

	Impact energy <i>E</i> (joules)			
	Group I		Group II	
Risk of mechanical damage	Normal	Low	Normal	Low
1. Light transmitting parts with guard (tested without guard)	4	2	2	1
2. Light transmitting parts without guards	7	4	4	2
3. Other enclosures or parts of enclosures (including guards and fan hoods)	20	7	7	4
NOTE — Where electrical apparatus is submitted to tests corresponding to the low risk of mechanical damage it shall be marked 'X' in accordance with item 9) of Sub-clause 25.2.				

The electrical apparatus is submitted to the effect of a test mass of M kg falling vertically from a height h , the values of M and h being dependent on the impact energy required as listed in Table IV. The test mass shall be fitted with an impact head of hardened steel in the form of a hemisphere of 25 mm diameter.

Table IV
Examples of Mass / Height to Yield Impact test levels

Impact Energy E (Joules)	Mass M (kg)	Height h (m)
1	0.25	0.4
2		0.8
4	1.0	0.4
7		0.7
20	2.0	1.0
NOTE – $h = E/Mg$ where $g = 10 \text{ m/s}^2$ h in meters E in joules M in kilograms		

An example of the standard free-fall test apparatus for fixed apparatus is shown in Annex A. When the conditions are such that this method cannot be used, a pendulum method may be used instead. In this case the striking element including the support rods or cords shall have a mass as specified in Table IV, and this mass shall be distributed so that the impact point is on the trajectory of the center of gravity of the moving system.

The surface of the hemispherical hardened steel impact head shall be checked before each test to ensure that it is in good condition and substantially free from damage.

Normally the test shall be made on the apparatus completely assembled and ready for use. Where this is not possible for light transmitting parts, the test shall be made with the parts removed but fixed in their mounting frame or on an equivalent frame. Where cement or bonding is used, the same materials shall be used to fix the transparent parts to the equivalent frame.

For light transmitting parts made of glass, the test shall be made once on each of three samples. In all other cases two tests shall be made on one sample. The point of impact shall be the place considered by the national or other appropriate authority to be the weakest.

Fixed electrical apparatus shall be mounted on a steel base ([see Annex A](#)) so that the direction of the impact is normal to the surface being tested if it is flat, or normal to the tangent to the surface at the point of impact if it is not flat. The base shall have a mass of at least 20 kg or be rigidly fixed or inserted in the floor (secured in concrete).

For suspended apparatus the direction of impact shall be normal to a flat surface or normal to the tangent at the point of impact if the surface is not flat.

The test shall be carried out at an ambient temperature of $25 \pm 10 \text{ }^\circ\text{C}$ except where the electrical apparatus has enclosures or parts of enclosures made of plastics material; in this case, it shall be made at a temperature of $10 \text{ K to } 15 \text{ K}$ above the service temperature of the electrical apparatus with a minimum of $50 \text{ }^\circ\text{C}$ and if necessary on another sample, at a low temperature of $-25 \pm 3 \text{ }^\circ\text{C to } -30 \text{ }^\circ\text{C}$. For electrical apparatus intended for use inside buildings, the low temperature test may be at $-5 \pm 3 \text{ }^\circ\text{C}$ and the electrical apparatus shall be marked accordingly.

For electrical apparatus with enclosures or parts of enclosures made of plastics material apparatus rated and marked for low ambients other than -20°C, additional tests shall be carried out at a temperature 5K to 10K lower than the low ambient. – e.g., for apparatus rated -50°C, tests are to be conducted at -55°C to -60°C.

~~Apparatus to be tested at a temperature different from the ambient temperature shall be placed in a climatic cupboard at a temperature not more than 10 K higher than the prescribed value when this is above the ambient temperature and not more than 5 K lower than the prescribed value when this is below the ambient temperature. After the temperature of the sample has stabilized it is removed from the cupboard, placed on the base and submitted to the test at the moment when the temperature reaches the prescribed temperature.~~

22.4.3.2 Drop tests

Portable electrical apparatus, ready for use, shall be dropped four times from a height of 1 m onto a horizontal concrete surface. The position of the sample for the drop tests shall be selected to represent the position most likely to cause failure of the enclosure. ~~by the national or other appropriate authority.~~

For non-plastics enclosed portable apparatus, the test shall be carried out at a temperature of 25 ± 10 °C. For electrical apparatus which has enclosures or parts of enclosures made of plastics material, the tests shall be carried out at -25 ± 3 °C to -30°C. ~~For electrical apparatus with enclosures or parts of enclosures made of plastics material apparatus rated and marked for low ambients other than -20°C, additional tests shall be carried out at a temperature 5 K to 10K lower than the low ambient. – e.g., for apparatus rated -50°C, tests are to be conducted at 55°C to -60°C.~~

22.4.3.3 Acceptance criteria

The impact and drop tests shall not produce damage invalidating the type of protection of the electrical apparatus.

Superficial damage, chipping of paint work, breakage of cooling fins or other similar parts of the electrical apparatus and small dents shall be ignored.

External fanhoods and screens may be deformed but displacement or deformation shall not cause rubbing by the moving parts.

22.4.4 Tests for the degree of protection provided by enclosures

When marked with a Degree of Protection, the tests are to be made in accordance with IEC Publication 529.

When marked with an Enclosure Type Designation, the tests are to be made in accordance with ANSI/UL 50 "Enclosures for Electrical Equipment."

22.4.5 Torque tests for bushings and terminal studs

Bushings and terminal studs used for connection purposes and subjected to torque when connections are made or removed shall be tested for resistance to torque and shall not turn when submitted to a torque of the value given in [Table V](#).

Table V
Torque to be applied to bushings and terminal studs used for connection purposes

Diameter of the stem (Metric/UNF or UNC)	M4	M5	M6	M8	M10	M12	M16	M20	M24
	#10	#12	1/4	5/16	7/16	1/2	5/8	7/8	1
Torque (N-m)	2.0	3.2	5	10	16	25	50	85	130

22.4.6 Thermal tests

22.4.6.1 Temperature measurement

The thermal tests shall be made at the rating of the electrical apparatus and with the most unfavorable voltage within 90 percent and 110 percent of the nominal voltage of the electrical apparatus unless other ~~IEC publications~~ applicable ANSI Standards prescribe other tolerances for equivalent industrial electrical apparatus. However, the measurement of the maximum surface temperature of rotating machines shall be made at the rated output and with the most unfavourable voltages within the range of 95 percent and 105 percent of the rated voltage (see 12.3 of amendment No. 1 (1987) of IEC 34-1). For ballasts for fluorescent lamps, the rectifier effect, simulated by a diode, shall be taken into account in addition to the test at 110 percent of the rated supply voltage (see IEC 82).

The measured maximum surface temperature shall not exceed:

- for electrical apparatus where each item is submitted to the thermal test, the maximum temperature as marked on the apparatus;
- for other electrical apparatus, the marked temperature less 5 K for temperature classes T6, T5, T4 and T3 and less 10 K for temperature classes T2 and T1.

The result shall be corrected for the maximum ambient temperature specified in the rating.

The measurement of the surface temperatures, temperatures of cable entries and temperatures of other parts as prescribed in this standard and the specific ~~IEC publication~~ ISA Standard for the type of protection concerned, shall be made in still, ambient air with the electrical apparatus mounted in its normal service position.

For electrical apparatus which can be nominally used in different positions, the temperature in each position is to be determined and the highest temperature is to be considered. When the temperature is determined for certain positions only, this shall be specified ~~in the test report~~ and the electrical apparatus shall be marked accordingly.

The measuring devices (thermometers, thermocouples, etc.) and the connecting cables shall be selected and so arranged that they do not significantly affect the thermal behavior of the electrical apparatus.

The final temperature is considered to have been reached when the rate of rise of temperature does not exceed 2 K/h.

22.4.6.2 Thermal stability of plastics enclosures

The thermal stability of plastics enclosures and of plastics parts of enclosures and of sealing gaskets on which the type of protection depends is satisfactory when these parts can withstand continuous storage for four weeks at not less than 90 ± 5 percent relative humidity and at a temperature $20 \text{ K} \pm 2$ above the maximum service temperature, with a minimum of 80 °C, without invalidating the type of protection of the electrical apparatus.

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 $(95 \pm 2)^\circ\text{C}$ and two weeks at a temperature of $(20 \pm 2) \text{ K}$ higher than the maximum service temperature.

The stability of plastics enclosures and plastics parts of enclosures at low temperatures is satisfactory when they can withstand storage for 24 h at a temperature of $-30 \pm 3^\circ\text{C}$ without invalidating the type of protection of the electrical apparatus.

NOTE – These requirements are under further consideration.

22.4.6.3 Thermal shock test

Glass parts of luminaires and windows of electrical apparatus shall withstand without breaking a thermal shock caused by a jet of water of about 1 mm diameter at a temperature of $10 \pm 5^\circ\text{C}$ sprayed on them when they are at maximum service temperature.

22.4.7 Insulation resistance test of plastics parts

The resistance is tested on the part itself if its size permits, or on a test piece as shown in Figure 2.

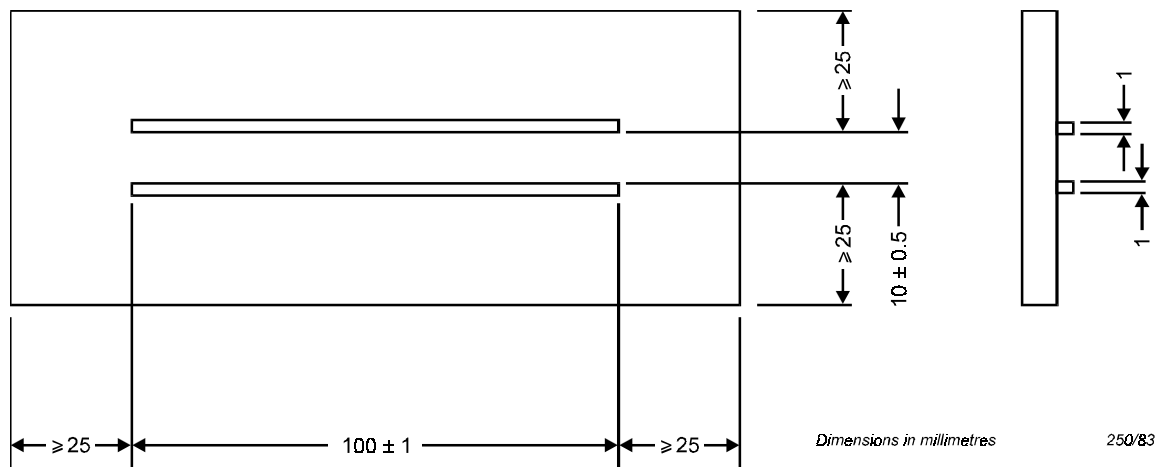


Figure 2 – Test piece with painted conducting electrodes

Two parallel electrodes are painted on the surface as shown in Figure 2 using a conducting paint with a solvent which does not affect the insulation resistance. The enclosure or test piece shall have an intact surface and be cleaned with distilled water, then by isopropyl alcohol or any other solvent miscible with water and not affecting the material of the specimen, cleaned again with distilled water and dried. Then, without being touched by hand, it shall be placed for 24 h in a clean atmosphere at a temperature of 23 ± 2 °C with a relative humidity between 48 percent and 52 percent.

The test is carried out as follows:

A voltage of 500 ± 10 V d.c. is applied between the electrodes for 1 min.

During the test this voltage shall be sufficiently steady for the charging current due to voltage fluctuation to be negligible compared with current flowing through the test piece. In some cases this may require the use of cells, batteries or accumulators.

The insulation resistance is the ratio of the direct voltage applied to the electrodes to the total current flowing between them when the voltage has been applied for 1 min. Possible methods are indicated in Annex B.

NOTE – This test is under further consideration.

22.4.8 Tests in explosive mixtures

The ~~part of IEC Publication 79 standard as specified in~~ [Sub-clause 1.1](#), specific to the type of protection concerned, states whether tests in explosive mixtures are required and the explosive mixtures to be used.

NOTE – The purity of commercially available gases and vapors is in general satisfactory for these tests but if their purity is below 95 percent they should not be used. The effect of normal variations in the laboratory of temperature and atmospheric pressure and of variations in the humidity of the explosive mixture are acceptable because they have been found to have a negligible effect. ~~For Group I apparatus tests may be carried out with natural methane containing at least 90% CH₄ provided that the total hydrocarbon content is at least 95%.~~

22.4.9 Tests of clamping of non-armored cables in cable entries

The tests of clamping of non-armored cables in cable entries shall be performed using for each type of cable entry sealing rings of the different allowable sizes. Each test is in two parts.

22.4.9.1 Clamping

In the case of elastomeric sealing rings, each ring is mounted on a clean, dry polished, cylindrical mild steel mandrel of a diameter equal to the smallest cable diameter allowable in the ring and specified by the manufacturer of the cable entry.

In the case of metallic sealing rings each ring is mounted on the metallic sheath of a sample of clean dry cable of a diameter equal to the smallest allowable in the ring and specified by the manufacturer of the cable entry.

The assembly is then fitted into the cable entry and the latter is mounted on a tensile test machine. The sealing ring is then compressed and a value observed of the tightening torque applied to the screws (in the case of a gland with clamp and screws) or the nut (in the case of screwed glands), necessary to prevent slipping of the mandrel or cable when the force applied to it reaches a value in newtons equal to 20 times the value in millimeters of the diameter of the mandrel or cable sample.

A torque is then applied to the screws or the nut of a value equal to 110 percent of that observed in the conditions defined above. A constant tensile force equal to that defined above is then applied for 6 h.

The tightness is considered sufficient if the slipping of the mandrel or the cable sample is not more than 6 mm.

22.4.9.2 Mechanical strength

The cable entry is then removed from the tensile test machine and is submitted to a test of mechanical strength by applying to the screws or the nut, whichever is the case, a torque of which the value is twice that which prevents slipping.

The cable entry is finally dismantled and the components examined.

The test is considered satisfactory if no noticeable damage is found. Any deformation of the sealing ring shall be ignored.

22.4.10 Tests of clamping of armored cables in cable entries

The tests of clamping of armored cables in cable entries shall be performed using for each size of entry a sample of armored cable of the smallest diameter allowable as indicated by the manufacturer of the cable entry. Each test is in two parts.

22.4.10.1 Clamping

The sample of armored cable is fitted into the clamping device of the cable entry and this is then mounted in a tensile test machine. The clamping device is then tightened and the value is observed of the minimum torque applied to the screws (in the case of a clamping device tightened by screws) or to the nut (in the case of the clamping device being a nut) necessary to prevent slipping of the cable when the applied force reaches a value in newtons equal to 80 times the value in millimeters of the diameter of the cable over the armor.

The tightness of the clamping device is considered sufficient if the slipping of the armor is effectively zero during 2 min of tension, the tensile force being maintained at a constant value.

22.4.10.2 Mechanical strength

The cable entry is then removed from the tensile test machine and is submitted to a mechanical strength test by applying to the screws or the nut, whichever is the case, a torque of which the value is twice that determined in the clamping test.

The cable entry is finally dismantled and the components examined.

The test is satisfactory if no noticeable damage is found.

23 Routine verifications and tests

~~The manufacturer shall make the routine verifications and tests necessary to ensure that the electrical apparatus produced complies with the specification submitted to the national or other appropriate authority together with the prototype or sample. He shall also make any routine verifications and tests required by the appropriate parts of IEC Publication 79. The manufacturer shall make any routine tests and verifications required by the appropriate parts of ISA Standards concerning specific types of protection for Class I, Zones 0 & 1.~~

24 Manufacturer's responsibility

~~By marking the electrical apparatus in accordance with Clause 25 the manufacturer attests on his own responsibility that the routine verifications and tests in Clause 23 have been successfully completed and that the product complies with the specification submitted to the national or other appropriate authority.~~

25 Marking

NOTE – In the interest of safety, it is essential that the system of marking indicated below is not applied to electrical apparatus which does not comply with this standard and with the part of IEC Publication 79 standard as specified in Sub-clause 1.1 specific to the type of protection concerned (see also Sub-clause 25.6).

25.1 The electrical apparatus shall be marked on the main part in a visible place. This marking shall be legible and durable, taking into account possible chemical corrosion.

Nameplates other than mechanically secured metal shall comply with tests for *Hazardous Locations Products* per ANSI/UL 969 "Marking and Labeling Systems."

NOTE – ~~For Group I apparatus, Appendix C gives an example of marking which is considered as legible and durable.~~

25.2 The marking shall include:

- 1) the name of the manufacturer or his registered trade mark;

- 2) manufacturer's type identification; - e.g. catalog number, part number
- 3) the symbol AEx, which indicates that the electrical apparatus has been constructed and tested for use in an explosive gas atmosphere or is specifically associated with such an apparatus;
- 4) the sign for each type of protection used:

"o" for oil-immersion oil-immersed apparatus;

"p" for pressurized enclosures;

"q" for powder-filling sand-filled apparatus;

"d" for flameproof enclosures;

"e" for increased safety;

"ia" for intrinsic safety category a;

"ib" for intrinsic safety category b;

"m" for encapsulation

a) Class I

b) The applicable Zone marking – i.e., Zone 0 or Zone 1.

- 5) the symbol of the group of the electrical apparatus:

I for electrical apparatus for mines susceptible to fire damp;

II or IIA or IIB or IIC for electrical apparatus for use in explosive gas atmospheres other than in mines susceptible to fire damp.

NOTE – The 1996 NEC does not recognize Group II, only IIA, IIB, and IIC.

The letters A, B, and C shall be used if the ~~part of IEC Publication~~ ISA Standard 79 specific to the type of protection concerned specifies this.

When the electrical apparatus is certified for use only in a particular gas, the symbol II shall be followed by the chemical formula or name of the gas;

- 6) for Group II electrical apparatus, the symbol indicating the temperature class or the maximum surface temperature in °C or both. When the marking includes both, the temperature class shall be given last in parentheses.

Example: T1 or 350 °C or 350 °C (T1).

Group II electrical apparatus having a maximum surface temperature greater than 450 °C shall be marked with the temperature only.

~~The ambient temperature range, if different from that specified in Sub-clause 4.1, shall be marked as decided by the national or other appropriate authority;~~

If rated for an ambient temperature range of other than -20 °C to +40 °C, the symbol "Ta" or "Tamb" together with the special range of ambient temperatures.

- 7) a serial number, if required, but not for:
- connection accessories (cable and conduit entries, blanking plates, adapter plates, plugs and sockets and bushings);
 - very small electrical apparatus on which there is limited space;
- 8) ~~when a certificate of compliance has been obtained, the name or mark of the national or other appropriate authority and the certification reference, preferably in the following form: the year of certification followed by the serial number of the certificate in that year;~~
- 9) specific installation instructions or reference to a specific installation document when the sign X after the certificate reference if the national or other appropriate authority considers that it is necessary to indicate special conditions for safe use;
- 10) any additional marking prescribed in the part of IEC Publication 79 standard as specified in Sub-clause 1.1 specific to the type of protection concerned;
- 11) any marking normally required by the standards of construction of the electrical apparatus.

25.3 Where different types of protection are used for different parts of an electrical apparatus, each respective part shall bear the sign for the type of protection concerned.

Where more than one type of protection is used in an electrical apparatus, the sign for the main type of protection shall appear first and be followed by the signs for the other types of protection used.

25.4 Markings 3) to 6) of Sub-clause 25.2 shall be placed in the order in which they are given above.

Examples giving the order of the indications:

- a) ~~electrical apparatus in flameproof enclosure for Group 1: Ex d 1;~~
- b) electrical apparatus in flameproof enclosure ~~for Group I and~~ for Group IIB, temperature class T3: Class I, Zone 1, AEx d IIB T3;
- c) ~~increased safety electrical apparatus and a pressurized enclosure for Group II (e.g. increased safety motor fitted with slip rings in a pressurized enclosure) with a maximum surface temperature of 125 °C:~~
~~Ex e p II 125 °C (T4) or~~

~~Ex e p II 125 °C or~~
~~Ex e p II T4.~~

- c) increased safety electrical apparatus incorporating a flameproof enclosure for Group IIC with a maximum surface temperature of 125 °C:

Class I, Zone 1, AEx e d IIC 125 °C (T4) or
Class I, Zone 1, AEx e d IIC 125 °C or
Class I, Zone 1, AEx e d IIC T4.

25.5 On very small electrical apparatus where there is limited space, ~~the national or other appropriate authority may allow~~ a reduction in the marking may be allowed, but at least the following will be required but will require at least:

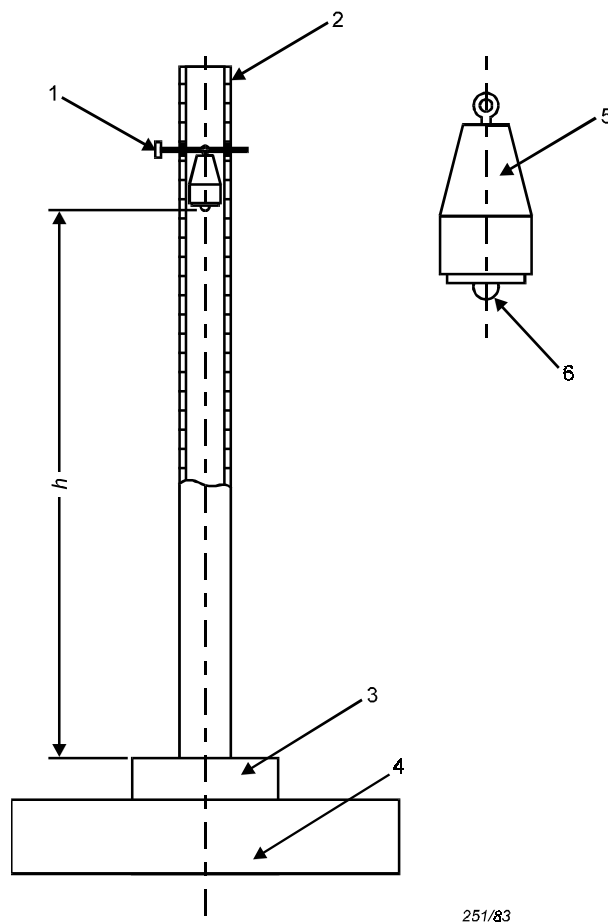
- a) the symbol AEx;
- b) ~~the name or mark of the national or other appropriate authority;~~
- c) ~~the certificate reference;~~
- d) the installation reference per 25.2 (9) ~~mark X, if appropriate;~~
- e) the name or registered trade mark of the manufacturer.

25.6 ~~Electrical apparatus which does not comply with the requirements of I E C Publication 79 but is recognized as safe by a national or other appropriate authority shall be marked with the symbol 'S'.~~

25.7 Where cautionary markings are required to be marked on the apparatus by this document, the text as described following the word "CAUTION" may be replaced by technically equivalent text.

Annex A – Example of free-fall test apparatus for impact test

(Informative)



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- 1. Adjustment pin
- 2. Plastics guide tube
- 3. Test piece
- 4. Steel base (mass ≥ 20 kg)
- 5. Steel mass (see Table IV)
- 6. Hardened steel impact head 25 mm diameter

h = height of fall (see Table IV)

Figure A

Annex B – Methods for insulation resistance tests of plastic parts

(Informative)

B1. Voltmeter-ammeter method

The current is measured directly by means of a microammeter, or a galvanometer (Figure B1), or indirectly by a d.c. amplifier which indicates the current by measuring the voltage drop which it determines in a known resistance (Figure B2a). The voltage is measured by a voltmeter. In certain cases, the voltage-current ratio is measured by an instrument indicating the resistance directly (Figure B2b).

B2. Comparative method

The unknown resistance is compared to a known resistance. This comparison is carried out by determining the ratio of the currents when the same voltage is applied in succession to two resistances (Figure B3a), or by balancing the two resistances in a Wheatstone bridge (Figure B3b).

For all these methods the known resistance shall be large in relation to any calibrated resistance connected in series with it so as to be submitted to practically all the voltage.

VOLTMETER-AMMETER METHOD

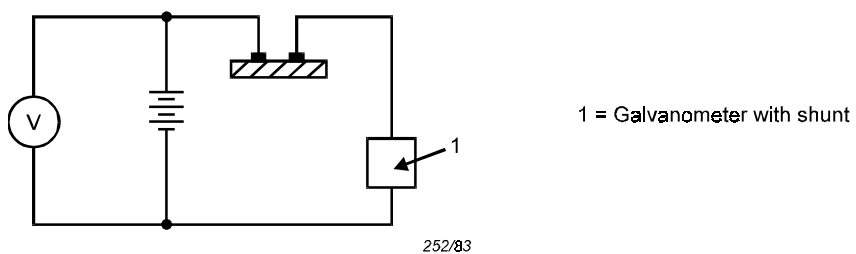


FIG. B1. — Current measurement by microammeter or galvanometer

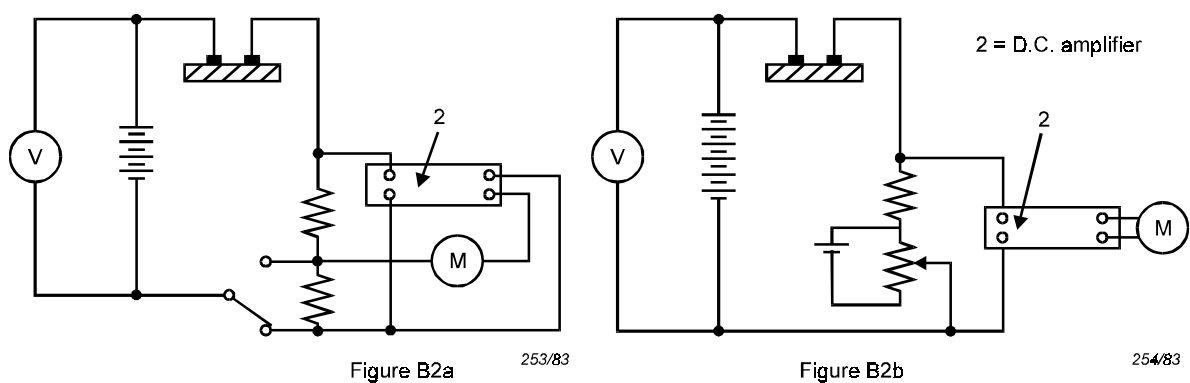


FIG. B2. — Current measurement by means of a d.c. amplifier.

COMPARATIVE METHOD

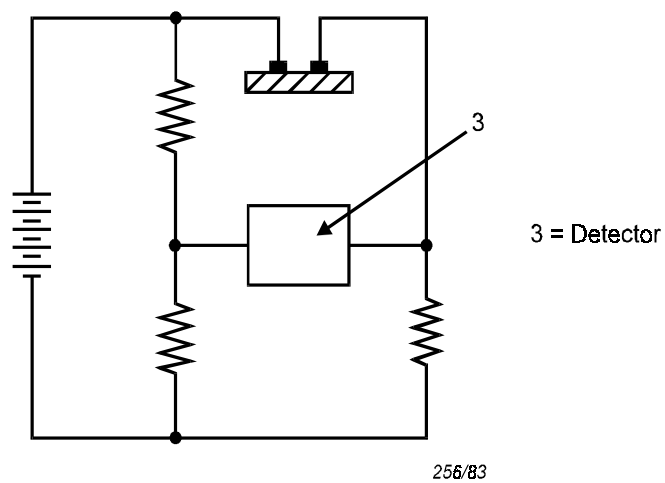
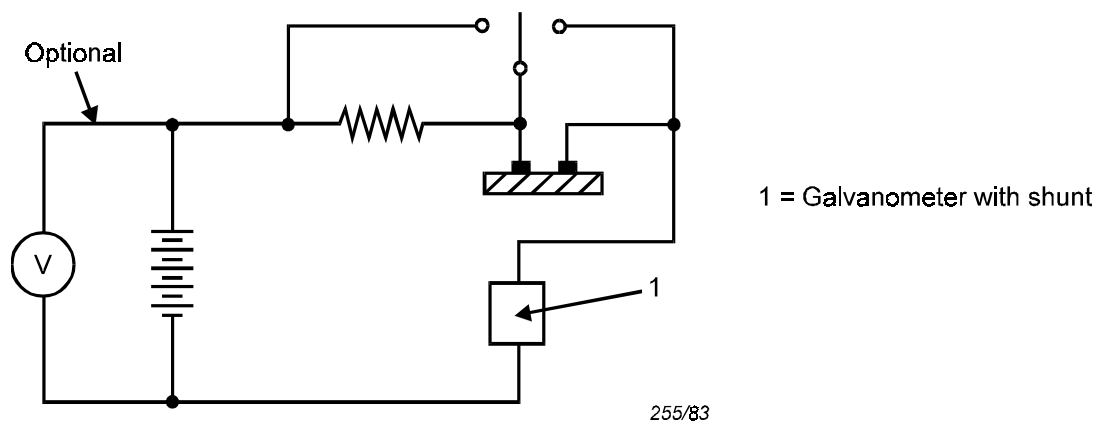


Fig.B3b. — Wheatstone bridge method.

APPENDIX C

(Informative)

EXAMPLES OF LEGIBLE AND DURABLE MARKING

Until completion of the procedures for verifying legibility and durability, the marking on Group I electrical apparatus:

- of the name of the manufacturer or his registered trade mark;
- of the manufacturer's type identification;
- of the national or other appropriate authority and of the certificate reference;
- of the serial number, if required;

is considered satisfactory if it complies with the following requirements:

C1. The characters shall be recessed or raised directly as part of the casting or moldings or be engraved directly on to the enclosure of the electrical apparatus or on a plate securely fixed to the enclosure. Alternatively, engraving by pressure or by chemical action may be used. The minimum height of the characters shall be 5 mm, the depth of recess, or relief, being at least $\frac{1}{10}$ of the height. On small electrical apparatus where the space available for marking is less, the characters may be reduced to 3 mm and 0.3 mm. On stainless steel labels the depth of engraving need not exceed 0.6 mm irrespective of the height of the characters.

C2. The labels shall have a thickness equal to $\frac{1}{25}$ of their largest dimension with a minimum of 2 mm. They shall consist of bronze or brass or stainless steel. The minimum thickness is reduced to 1 mm if the plate is fixed by a frame or if it is soldered or brazed round the whole of the periphery or if it is recessed.

C3. The label shall be fixed to the principal part of the enclosure:

- by soldering or brazing, either directly or by means of a frame;
- by sunken headed screws, locked in place by punching or soldering;
- by riveting through the wall of the enclosure, if permitted by the type of protection concerned;
- in the case of plastics enclosures, by bonding into a recess.

C4. If the serial number is required, it shall be stamped or engraved directly on the enclosure or on the labeling plate defined above.

ANNEX D (Informative) — U.S. 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 Marking. The word "CAUTION" has been added as a prefix to required cautionary markings.

General Certification. All text has been deleted that inferred that third party certification was required.

1.4 This standard also requires conformance to the applicable requirements for similar apparatus for use in unclassified locations.

Text has been added to conform to U.S. practice for hazardous locations electrical apparatus.

2. Definitions for luminaire and Ex component have been added to help promote a uniform understanding of the terms.

Table 3.2.1. Table has been added to provide an approximate comparison of the IEC (NEC - 505) Gas Groups and the traditional U.S. (NEC - 500) Gas Groups.

5.2 Optional marking has been permitted to eliminate the need to conduct a detailed internal temperature and stored charge analysis.

Permitted marking is consistent with current U.S. and CENELEC practice.

8.2 Requirements for "Special Fasteners" have been deleted.

Deletion of "Special Fasteners" is consistent with EN 50.014 2nd Edition and proposed IEC 79-0 3rd Edition.

13. Mandatory external bonding terminal has been deleted. U.S. term of "equipment grounding" has been used in place of "earthing."

NEC does not include requirements for the connection of an external bonding terminal. It should be noted that providing such a terminal has not been prohibited. The term "equipment grounding" is added to align with NEC.

15.6 Permitted temperatures at terminals have been lowered from 70 °C to 60 °C.

Change required to align with NEC.

19. Appropriate enclosure Type designations have been added as alternates to IP43.

To permit use of U.S. rated enclosures.

Table IV. Table has been revised to show the height and mass as examples not requirements.

Required test is a specific energy; height and mass are examples provided to yield the required energy.

22.4.3.1 Text has been revised to upper limit for low ambient test and lower limit for high ambient test. A specific requirement has been added to ambients below -20 °C.

Text revised to permit testing of low thermal mass samples while still achieving the intended results. Details on low ambient test are added to allow consistency.

22.4.3.2 Text has been revised to upper limit for low ambient test and lower limit for high ambient test. A specific requirement has been added to ambients below -20 °C.

Text is revised to permit testing of low thermal mass samples while still achieving the intended results. Details on low ambient test are added to allow consistency.

22.4.4 A test requirement has been added for enclosures marked with a "Type" designation.

To accommodate U.S. industry practice.

22.4.6.2 Text has been added to permit testing of plastics of apparatus rated at greater than 75 °C.

Added text is consistent with EN 50.014 2nd Edition and proposed IEC 79-0 3rd Edition.

25.1 Requirements have been added for non-metallic nameplates.

Added text is consistent with current U.S. practice.

25.2 3). An "A" prefix has been added to "Ex."

Added marking is to designate apparatus conforming to these U.S. requirements and differentiate from similar Australian, Canadian IEC, and European national marking using only "Ex." Marking is a similar approach to the European Community designation of "Ex."

25.2 4). Additional markings of "Class I" and "Zone" have been added.

Added marking is an NEC requirement.

25.2 8). The requirement for a Certificate has been deleted.

A Certificate is not consistent with U.S. industry practice.

25.2 9). Requirements for "X" mark after Certificate reference have been replaced with installation instructions or reference to specific installation instructions.

Reference with installation instructions or reference to specific installation instructions is consistent with current U.S. industry practice.

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