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Approved December 15, 1997

Standard

Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations Type of Protection – *Flameproof* "d"

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-S12.22.01—Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations Type of Protection – *Flameproof "d"*

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Preface

This ISA Standard is based on IEC Publication 79-1. It is the intention of the SP12.22 Subcommittee to develop an ANSI Standard that is harmonized with IEC 79-1 to the fullest extent possible.

This preface, as well as all footnotes and annexes, is included for informational purposes only and is not a part of ISA-S12.22.01 (IEC 79-1 Mod). This standard has been prepared as a part of the service of ISA, the international society for measurement and control, toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P.O. Box 12277; Research Triangle Park, North Carolina 27709; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: standards@isa.org.

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Contents

Foreword

All text of IEC 79-1 (with Amendment 1) is included. U.S. National Deviations are shown by ~~strikeout~~ through text deleted and underline under text added. Figures to be deleted are marked with the overlay "Figure Deleted." A note appears in the table title showing the table as added material. There are three annexes in this Standard. Annex C is Informative and is not considered part of this Standard. Annexes A and B are Normative and are considered part of this Standard.

Preface

The following documents may contain provisions which, through reference in this text constitute provisions of this standard. At the time of publication of this standard, the editions indicated were valid. All documents are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the 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.

The following ~~IEC~~ publications are quoted in this standard:

Publications Nos.

~~IEC 79-0 (1983) Electrical apparatus for explosive atmospheres, Part 0: General requirements.~~

ISA S12.0.01 (IEC 79-0 MOD) Electrical apparatus for use in Class I, Zones 0 & 1, Hazardous (Classified) Locations - *General Requirements*.

ISA S12.16.01 (IEC 79-7 MOD) Electrical apparatus for use in Class I, Zone 1, Hazardous (Classified) Locations Type of Protection - *Increased Safety "e"*.

ISA-S12.1.01 (1991) — Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations.

IEC 79-1A (1975) First Supplement: Appendix D: Method of test for ascertainment of maximum experimental safe gap.

~~IEC 112 (1979) Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.~~

IEC 707 (1992) — Methods of Test for the Determination of the Flammability of Solid Electrical Insulating Materials When Exposed to an Igniting Source.

Other publications quoted:

~~ISO Standard 179 (1982) Plastics – Determination of Charpy impact strength of rigid materials.~~

ISO Standard 468 (1982) Surface roughness – Parameters, their values and general rules for specifying requirements.

~~ISO Standard 965-1 (1989) ISO General purpose metric screw threads – Tolerances – Part 1: Principles and basic data.~~

~~ISO Standard 965-3 (1980) ISO general purpose metric screw threads – Tolerances – Part 3: Deviations for constructional threads.~~

ISO Standard 1210 (1982) Plastics – Determination of flammability characteristics of plastics in the form of small specimens in contact with a small flame.

~~ISO Standard 1817 Rubber, vulcanized – Determination of the effect of liquids.~~

ISO Standard 2738 (1987) Permeable sintered metal materials – Determination of density, oil content and open porosity.

ISO Standard 4003 (1977) Permeable sintered metal materials — Determination of bubble test pore size.

ISO Standard 4022 (1987) Permeable sintered metal materials – Determination of fluid permeability.

~~ISO Standard 4892 (1981) Plastics – Methods of exposure to laboratory light sources.~~

ANSI/ASME B1.1 (1989) — Unified Inch Screw Threads (UN and UNR Thread Form).

ANSI/ASME B1.20.1(1983) — Pipe Threads, General Purpose (Inch).

ANSI/ASME B46.1 (1985) — Standard for Surface Texture.

ANSI/ASTM E28 (1992) — Standard Test Method of Softening Point by Ring-and-Ball Apparatus.

ANSI/UL 746C (1989) — Polymeric Materials – Use in Electrical Equipment Evaluations.

For technical reasons, certain symbols which appear in italic type in the text are in roman type in the tables.

Construction and verification test of flameproof enclosures of electrical apparatus

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SECTION ONE - GENERAL

1 Scope

1.1 This standard specifies the constructional features and test requirements for flameproof enclosures of electrical apparatus intended to be used in Class I, Zone 1, explosive gas atmospheres. In addition, flameproof enclosures shall comply with the applicable requirements of ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod).

This standard applies to enclosures and parts of enclosures constructed of metallic and non-metallic materials. ~~Some additional requirements may be necessary for non-metallic materials and these are left to the discretion of the national or other appropriate authority~~. See ~~Appendix~~ Annex A.

1.2 The ambient temperature range of -20°C to + 60°C for the explosive gas atmosphere characteristics and -20°C to + 40°C for the operation of electrical apparatus as given in ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) also apply to this standard. In ambient temperatures below -20°C, stronger enclosures may be required due to the higher explosion pressures generated at low temperatures and the possibility of brittle failure of enclosure materials. For ambient temperatures above 60°C, it may be necessary to use smaller joint gaps because the maximum safe gap tends to decrease with an increase in ambient temperature.

1.3 This ~~part of IEC 79~~ ISA standard deals only with flameproof enclosures and not with other means of protection against an explosion hazard. These are covered by separate standards.

2 Definitions

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

2.1 flameproof enclosure: A type of protection of electrical apparatus in which the enclosure will withstand an internal explosion of a flammable mixture which has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapors for which it is designed.

NOTE – This type of protection is indicated by the letter "d".

2.2 volume: The total internal volume of the enclosure, except where the enclosure and its contents are inseparable in use, in which case the volume is the free volume.

NOTE – For luminaires, the volume is determined without lamps fitted**.**

2.3 flameproof joint: The place where corresponding surfaces of the different parts of a flameproof enclosure (or the conjunction of enclosures) come together, and where flame or the products of combustion may be transmitted from inside to outside the enclosure.

2.4 length of flame path (width of a joint): The shortest path through a joint from the inside to the outside of a flameproof enclosure.

NOTE – This definition does not apply to threaded joints.

2.5 gap (diametral clearance): The distance between the corresponding surfaces of a flameproof joint. For cylindrical surfaces, the gap is the diametral clearance (difference between the two diameters).

2.6 shaft: A component of circular cross-section used for transmitting rotary motion.

2.7 operating rod (spindle): A component of circular cross-section used for transmitting control movements which may be rotary or linear or a combination of both.

2.8 pressure piling: A condition resulting from ignition of pre-compressed gases in compartments or sub-divisions other than those in which ignition was initiated.

2.9 Maximum Experimental Safe Gap (MESG): The maximum clearance between two parallel metal surfaces which has been found, under specified test conditions, to prevent an explosion in a test chamber from being propagated to a secondary chamber containing the same gas or vapor at the same concentration.

2.10 indirect entry: A method of connection of an electrical apparatus to the electrical circuits by means of a terminal box or a plug and socket connection which is external to the main enclosure. (IEV 426-04-08)

2.11 direct entry: A method of connection of an electrical apparatus to the external circuits by means of the connecting facilities inside the main enclosure or in a terminal compartment having a free opening to the main enclosure. (IEV 426-04-07)

2.12 factory sealed: A construction where components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions are isolated from the wiring system by means of factory installed flameproof seal or joint.

3 Grouping and temperature classification

The grouping and temperature classification defined in ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod) shall apply to flameproof enclosures. The sub-divisions A, B, and C shall apply for electrical apparatus of Group II.

NOTE – For additional information on grouping and temperature classification, see ISA-S12.1:1991.

SECTION TWO – CONSTRUCTIONAL REQUIREMENTS

4 Flameproof joints (joints)

4.1 General requirements

All joints in the enclosure, whether permanently closed or designed to be opened from time to time, shall satisfy the requirements for flameproof joints given in Tables ~~I~~, IIA, IIB, IIC and III and the following:

NOTES—

1. ~~Special joints such as labyrinth joints (see Figure 1) or serrated joints (see Figure 2) are permitted. However, the construction and test requirements for such joints are not described in this standard. Testing of such joints may require a greater number of explosion tests and the introduction of additional safety factors as determined by the testing laboratory.~~

2. The surfaces of joints may be protected against corrosion, but coating with paint or similar material is not normally permitted unless the material and the application procedure have been shown not to adversely affect the flameproof properties of the joint.

4.2 Non-threaded joints

4.2.1 Width of joints

The width of joints for cylindrical metallic parts (e.g. ~~bushes~~ bushings should this word be "bushing" press-fitted into the walls of a metallic flameproof enclosure of volume not greater that 2000 cm^3) may be reduced to 5 mm if the design:

- does not rely on an interference fit to prevent the part from being displaced during the type tests of Clause 14,

- meets the impact requirements of ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod), as required by Clause 13, taking worst interference fit tolerances into account, and

- the diameter of the press-fitted part does not exceed 60 mm.

Where joints include conical surfaces, the width of joint and the gap normal to the joint surfaces shall comply with the relevant dimensions given in Tables ~~I,~~ IIA, IIB, and IIC. The gap shall be uniform throughout the conical part. For Group IIC enclosures the cone angle shall not exceed 5°.

4.2.2 Surface roughness

The surface of joints shall be machined so that its average roughness R_a (ISO 468) does not exceed 6.3 µm (250 microinches in accordance with ANSI/ASME B46.1).

4.2.3 Gap

There shall be no intentional gap between flanged joint surfaces except when necessary for quick acting doors or covers. The gap, if any, between joint surfaces shall nowhere exceed the appropriate maximum value given in Table ~~I,~~ IIA, IIB or IIC.

~~For Electrical apparatus of Group I, it shall be possible to check directly, or indirectly, the gaps of flanged joints of doors and covers designed to be opened from time to time. (See Figure 3)~~

4.2.4 Spigot joints (rabbet joints)

For the determination of the width of spigot joints, the following shall be taken into account:

- Either the cylindrical part and the plane part, in which case the following additional conditions shall apply (see Figure 4):

  $L = c + d$

  $c \geq 6$ mm (IIC only)

  $d \geq 0.5\ L$ (IIC only)

  $f \leq 1$ mm

- or the cylindrical part only (see Figures 5, 6 and 7), in which case the plane part shall satisfy the following requirements:

- for Groups ~~I,~~ IIA and IIB, the plane part need fulfill no gap requirements;

- for Group IIC, the gap of the plane part shall not exceed the maximum gap specified in Table IIC for the cylindrical part.

If a gasket is provided in the plane part (see Figure 6), the gap of the plane part shall be measured after compression of the gasket. The minimum width of joint of the cylindrical part shall be maintained before and after compression of the gasket. However, if a metallic or metal-clad compressible gasket is used for electrical apparatus of Group IIC (see Figure 7), the gap between each surface of the plane part and the sealing gasket shall be measured after compression.

4.2.5 Flanged joints for Group IIC

Flanged joints are permitted for Group IIC intended for use in an explosive atmosphere containing acetylene only if the conditions of note 2 of Table IIC are complied with.

NOTE – Appropriate measures for preventing ignition of the surrounding atmosphere due to the projection through the joints of internal deposits of debris or dust, and in particular of carbon deposits which can be produced by incomplete combustion of acetylene, are, for example, the provision of gaskets (see 4.4), angled or labyrinth joints, deflectors or screens.

4.2.6 Holes in joints

If a joint surface is interrupted by holes for clamping bolts or the like, the minimum value of the distance *l*, as shown in Figures 8, 9 and 10, shall be as follows:

- for widths of joint less than 12.5 mm6 mm
- for widths of joint greater than or equal to 12.5 mm, but less than 25 mm...8 mm
- for widths of joint greater than or equal to 25 mm9 mm

~~**NOTE:** Some countries may require the distance *l* to exceed the above values.~~

The distance *l* shall be determined as follows:

4.2.6.1 Flanged joints

The distance *l* shall be measured between each hole and the inside of the enclosure where the hole is outside the enclosure and between each hole and the outside of the enclosure where the hole is inside the enclosure (see Figures 8, 9 and 10).

4.2.6.2 Spigot joints

The distance *l* is the sum of the width *a* of the cylindrical part and the width *b* of the plane part, if *f* is less than or equal to 1 mm and if the gap of the cylindrical part is less than or equal to 0.2 mm for Group~~s I and~~ IIA, 0.15 mm for Group IIB or 0.1 mm for Group IIC (reduced gap) (see Figure

11) or the width *b* of the plane part alone, if either of the above mentioned conditions is not met, in so far as the plane joints are permitted.

4.3 Threaded joints

4.3.1 For Groups ~~I,~~ IIA and IIB enclosures, the threaded joints shall have a minimum of five full threads engaged and a minimum direct axial length of thread engagement of 8 mm for a volume > 100 cm^3 and 5 mm for a volume of ≤ 100 cm^3.

4.3.2 For Group IIC enclosures, threaded joints shall comply with the requirements given in Table III.

NOTE – The values may be used for Groups~~ I,~~ IIA and IIB enclosures.

4.4 Gaskets and o-rings

4.4.1 If a gasket of compressible material is used (e.g., for IP protection against ingress of moisture or dust, or to retain a liquid filling), it shall be applied as a supplement to, but shall not be included in, the flameproof joint (see Figures 12 to 15). This requirement does not apply to the entry of conductors and cables or to transparent elements of luminaires.

The gasket shall not prevent the correct closure of the flameproof joint to meet the requirements of Tables ~~I,~~ IIA, IIB or IIC.

4.4.2 Joints of bushings and light-transmitting parts may contain a gasket if this is of metal or a compressible non-flammable material, as determined by ISO 1210, with a metal sheath. Such a gasket contributes to the explosion protection and is an exception to the requirement of 4.4.1.

4.5 Cemented joints

4.5.1 Where cement or sealing material is used, the design shall be such that the strength of the enclosure does not depend upon the cement or sealing material.

4.5.2 The shortest path through a cemented joint from the inside to the outside of a flameproof enclosure of volume V shall be:

≥ 3 mm, if V ≤ 10 cm^3
≥ 6 mm, if 10 cm^3 < V ≤ 100 cm^3
≥ 10 mm, if V > 100 cm^3

4.5.3 Joints need not comply with the requirements of 4.5.2 if the parts are either cemented directly into the wall of the enclosure so as to form an inseparable assembly, or are cemented into a metallic frame so that the assembly can be replaced as a unit without damaging the cement.

4.6 Labyrinth joints

Labyrinth joints need not comply with Tables IIA, IIB, or IIC, but shall be shown to satisfy the test requirements of 14.2. (See Figure 1.)

4.7 Serrated joints

Serrated joints need not comply with the requirements of Tables IIA, IIB or IIC but shall have

a) at least five fully engaged serrations;

b) a pitch (T) greater than or equal to 1.25 mm; and

c) an included angle (α) of $60 \pm 5°$.

In addition, serrated joints shall be shown to satisfy the test requirements of 14.2, with the tested length reduced by one-third. The test factors required by 14.2 shall not be additionally applied. (See Figure 2.)

5 Operating rods (spindles)

Where an operating rod or spindle passes through the wall of a flameproof enclosure, the following requirements shall be met:

5.1 The length of the operating rod or spindle supported by the wall of the enclosure shall be equal to at least the minimum width of joint specified in Tables ~~I,~~ IIA, IIB or IIC for the appropriate volume of enclosure.

5.2 If the diameter of the operating rod or spindle exceeds the minimum width of joint specified in Table ~~I,~~ IIA, IIB or IIC, the width of joint shall be not less than the diameter of the operating rod or spindle, except that the width of joint need not exceed 25 mm.

5.3 The diametral clearance where the operating rod or spindle passes through the hole in the enclosure shall not exceed the appropriate maximum value given in Table ~~I,~~ IIA, IIB or IIC.

~~**5.4** If the diametral clearance is likely to be enlarged by wear in normal use, means shall be provided to counteract any such enlargement, for example, a replaceable bushing. In extreme cases, a gland which is not subject to wear in normal use shall be added.~~

6 Shafts and bearings

A flameproof gland (joint) shall be provided wherever a shaft passes through the wall of a flameproof enclosure. The gland shall be so designed that it will not be subjected to wear by decentralization or wear of the bearing.

The gland may be a plain fixed gland (see Figure 16), a labyrinth gland (see Figure 1) or a floating gland (see Figure 17).

Subject to the requirements of the following sub-clauses, the length of the flame path and diametral clearance shall be in accordance with Table ~~I,~~ IIA, IIB or IIC, as appropriate.

The minimum radial clearance *k* (see Figure 18) of shafts of rotating machines shall be not less than 0.075 mm for Groups ~~I,~~ IIA and IIB and not less than 0.05 mm for Group IIC.

6.1 Sleeve bearings

The length of flame path in a flameproof gland associated with a sleeve bearing shall be not less than the diameter of the shaft, except that the length of flame path need not exceed 25 mm.

If a plain fixed gland or a labyrinth gland is used for a rotating machine having sleeve bearings, and the radial clearance between the rotor and the stator is greater than the radial movement permitted by the gland, the gland shall be of non-sparking material (e.g. brass) (see Figures 19 and 20). This requirement does not apply to floating glands.

Sleeve bearings are not permitted for rotating electrical machines of Group IIC.

6.2 Rolling-element bearings

Shaft glands equipped with rolling-element bearings, shall have a maximum calculated radial clearance of "m" (see Figure 18) not greater than two-thirds of the maximum gap permitted for such glands in Tables ~~I,~~ IIA, IIB or IIC.

6.3 Plain glands

Where a plain gland with grooves for grease seals is used, the part containing the grooves shall be disregarded in determining the length of the flame path. The uninterrupted length of the gland shall not be less than the appropriate value given in Table ~~I,~~ IIA, IIB or IIC (see Figure 16).

The diametral clearance shall not exceed the appropriate values given in Table ~~I,~~ IIA, IIB or IIC but shall be not less than 0.1 mm.

7 Light-transmitting parts

In addition to the requirements of this standard, light-transmitting parts such as inspection windows and transparent covers for luminaires shall withstand the relevant tests in ~~IEC 79-0~~ ISA-S12.0.01 (IEC 79-0 Mod).

7.1 Material

Glass or any suitable substitute may be used. A substitute for glass shall be chemically and physically stable and shall be capable of withstanding effectively the maximum temperature of the apparatus under the rated conditions.

7.2 Mounting of light-transmitting parts

7.2.1 The sealing, cementing or gasket used for fixing the light-transmitting part shall satisfy the general requirements specified in 4.4 and 4.5.

7.2.2 A light-transmitting part shall be mounted in one of the following ways:

- The transparent material may be sealed directly into the enclosure to form an integral part of it;
- The transparent material may be clamped directly into the enclosure, with or without a gasket;
- The transparent material may be sealed or cemented into a frame which is clamped into the enclosure, so that the window may be replaced as a unit without having to affect sealing on site.

7.2.3 Precautions shall be taken so that the mountings of light-transmitting parts do not produce undue internal mechanical stress in those parts.

8 Breathing and draining devices

8.1 Breathing and draining devices, if required for technical reasons, shall be so constructed that they are not likely to become unsafe in service (e.g., by accumulation of dust or paint). Provision for breathing or draining shall not be made by deliberately increasing the gap of a flanged joint. (~~Appendix~~ Annex B)

8.2 The dimensions of the openings constituting the vent shall provide a margin of safety in relation to the dimensions that can be shown by test to be flameproof (as defined in this standard).

8.3 If the device is constructed so that it can be taken to pieces, it shall be designed so that it is not possible to reassemble the parts in such a way as to either reduce or enlarge the openings constituting the vents.

9 Fasteners

9.1 Where removable screws or studs are used for securing any component parts of the flameproof enclosure, the holes for such screws or studs shall not pass through the walls of the enclosure.

The thickness of the metal surrounding a hole shall not be less than 3 mm or one-third of the diameter of the hole, whichever is greater.

9.2 There shall be a free space between the end of the screw or bolt and the bottom of the hole when the screw or bolt is screwed fully home without a washer.

9.3 If, for convenient manufacture, holes are drilled through the wall of the enclosure, such holes shall be blinded by inserting a screwed plug providing a joint in accordance with the requirements in Table III. Such plugs shall be fixed as described in 9.4.

9.4 Screws or studs which are permanently attached to the enclosure shall be securely welded or riveted, or attached by some other equally effective means.

9.5 Where necessary, means shall be provided to prevent fasteners from being loosened by vibration.

~~**9.6** For Group I enclosures, fasteners used for securing doors, covers and blanking plates to the flameproof enclosure shall comply with the requirements of special fasteners in IEC 79-0.~~

10 Mechanical strength of the enclosure

10.1 The flameproof enclosure shall be capable of sustaining the relevant internal test pressure specified in Section Three, without suffering damage or such deformation as would weaken any part of the enclosure, or would permanently enlarge any joint in the enclosure so as to exceed the gap specified in Table ~~I,~~ IIA, IIB or IIC.

10.2 Where two or more flameproof enclosures are incorporated together, the requirements of this standard apply independently to each, and particularly to the partitions between them and to any terminals or operating rods that pass through the partitions.

10.3 Where an enclosure comprises two or more communicating compartments or is sub-divided by the disposition of the internal parts of apparatus, pressure piling (as defined in 2.8) may occur. This generally results in an abnormally rapid rise of pressure and may lead to a higher maximum pressure than would otherwise be expected. The shape of the inside of the enclosure shall be such that pressure piling is precluded, as far as is practicable. If it is impracticable to avoid pressure piling, the mechanical strength of the enclosure shall be increased to allow for it.

10.4 Liquids shall not be used in flameproof enclosures when there is a risk of producing an explosive mixture more dangerous than that for which the enclosure was designed.

11 ~~Connection of conductors and cables~~ Conduit and cable entries

11.1 ~~Conductors~~ Conduits and cables may be connected by either of the two following methods:

- indirect entry, by means of a terminal box or plug and socket connection;
- direct entry, inside the main enclosure.

With either method, precautions shall be taken to guard against disturbance of the conductor terminations if the cable is pulled or twisted.

11.2 ~~Equipment intended for conduit connection shall be provided with an appropriate size of conduit opening threaded for engagement of at least five threads~~. Equipment intended to be permanently installed shall be equipped with threaded entries using a modified National Standard Pipe Taper (NPT) thread with thread form per ANSI/ASME B1.20.1. Entries shall not be smaller than trade size ½ nor larger than trade size 6 and must provide for five full threads of engagement with a conduit or fitting gauging at L1 -1. Entries shall conform to ANSI/ASME B1.20.1 except that entries shall gauge with +1/2 to +3-1/2 turns beyond the L-1 gauging notch in lieu of the -1 to +1 turns described in ANSI/ASME B1.20.1. Equipment not factory-supplied with entries shall have wall sections of sufficient thickness to permit the addition of entries meeting these requirements. Where an integral bushing (historically known as a conduit stop) is not provided, the inner end of the entry shall be smooth and well-rounded.

EXCEPTION: If an integral bushing is provided in the entry of an enclosure for Group IIA or IIB locations, or both, NPS straight threads shall be permitted if there are a minimum of five full threads.

The manufacturer shall state in the documents defining the electrical apparatus, those means which are explicitly intended to be used for cable and conduit entries, the place where they can be mounted, the maximum permitted numbers of these means, and any other instructions

necessary to provide acceptable cable and conduit entries in accordance with the requirements of this standard.

11.3 Indirect entry

If the terminal box is to be protected by flameproof enclosure, the requirements of 11.4 shall be met. If it is to be protected by some other method, it shall meet the requirements applicable to that method. In addition, the following requirements shall be met.

11.3.1 Connections between external conductors and cables and the circuits inside the flame-proof enclosure shall be made through bushings or other means complying with clause 4 ~~inserted~~ in the wall separating the two chambers.

~~**11.3.2** The bushings may be replaced by conductors provided with sealing glands which do not alter the flameproof properties of the enclosure.~~

11.3.3 The use of a plug and socket connection is permitted as an indirect entry if the construction is such that the flameproof properties of the enclosure are not altered when the plug and socket are separated.

11.3.3.1 The width and the gap of the flameproof joints of the flameproof enclosures of plugs and sockets shall be determined by the volume which exists at the moment of separation of the contacts other than those for earthing or bonding or those which are intrinsically safe.

11.3.3.2 For plugs and sockets the properties of the flameproof enclosure, type of protection "d", shall be maintained in the event of an internal explosion both when the plugs and sockets are connected together and at the moment of separation of the contacts other than those for earthing or bonding or those which are intrinsically safe.

~~**11.3.3.3** The requirements of 11.3.3.1 and 11.3.3.2 do not apply to plugs and sockets fixed together by fasteners in accordance with the second paragraph of clause 19 of IEC 79-0.~~

11.4 Direct entry

Direct entry of ~~conductors~~ conduits or cables shall be by means ~~of packing glands or with sealing material~~ which do not alter the flameproof properties of the enclosure.

~~Minimum width of seal X shall comply with the requirements of Tables I, IIA, IIB or IIC for minimum width of flame path with the packing material compressed (See Figures 21, 22, and 23).~~

~~If the cable is sealed into the main enclosure, a length of at least 1 m shall be attached to the enclosure.~~

~~When equipment is provided with means for attaching conduit, the conductors or cable shall pass into the enclosure through a compound-filled box or recess which may be either integral with the enclosure or attached to it.~~

A seal may be of the poured or molded type. Seals of the poured or molded type are acceptable only for joints that are not intended to be disturbed after assembly.

Sealing compounds for use in flameproof seals shall be evaluated as non-metallic materials per Annex A. Additionally, sealing materials shall be subjected to the explosion pressure and flame transmission tests specified in sub-clauses 14.1 and 14.2. Sealing material shall be compatible with other materials which may come into contact with it or pass through it. Degradation of cement-based materials under conditions of exposure to high humidity shall be considered. The softening point of the sealing material, per ASTM-E28-92, shall not be less than 93ºC, nor less than the operating temperature conditions of the equipment under normal or overload conditions.

The mechanical integrity of an explosionproof seal shall not rely entirely on the adhesive properties of the sealing compound. Supplemental mechanical retention of the sealing compound shall be provided. The thickness of a poured or molded seal shall not be less than 10 mm. If a nipple is used to retain the sealing compound, the thickness shall not be less than the internal diameter of the nipple or 16 mm, whichever is greater.

The seal shall be subjected to the air leakage test of sub-clause 14.3.

12 Marking

12.1 The marking for flameproof enclosures shall meet the requirements in ISA-S12.0.01 (IEC 79-0 Mod) ~~IEC 79-0~~.

Covers giving access to the interior of enclosures shall either be interlocked with a disconnector, or bear a label indicating that the cover shall not be opened when the apparatus is energized.

12.2 Apparatus evaluated per sub-clause 14.1.1(a) Exception, shall be marked with the word "WARNING" and the following or equivalent wording. "Seal entries within ‘XX’ of enclosure." Dimension "XX" is to be determined from the results of the explosion pressure testing.

12.3 Apparatus evaluated per sub-clause 14.1.1 (c), shall be permitted to be marked "Factory Sealed. "

12.4 Equipment evaluated per sub-clause 14.1.1 (d), shall be permitted to be marked "Conduit Seal Not Required."

13 General

For protection by flameproof enclosure, the requirements of ISA-S12.0.01 (IEC 79-0 Mod) ~~IEC 79-0~~ concerning verifications and tests are supplemented by the following requirements.

14 Type tests

~~Normally~~, The tests in ISA S12.0.01 (IEC 79-0 Mod) ~~IEC 79-0~~ shall be carried out first and then those below shall be carried out in the order given.

Individual flameproof compartments of multiple compartment apparatus shall be subjected to evaluation and testing of each compartment.

14.1 Tests of ability of the enclosure to withstand pressure

The object of these tests is to confirm that the enclosure can effectively resist an internal explosion.

Compliance of the enclosure shall be determined by the tests specified in 14.1.1 and 14.1.2.

The enclosure shall be tested with all the internal apparatus or its equivalent in position, but if it is so designed that it can be used with part of the internal apparatus removed, the tests shall be made under the conditions ~~which the testing laboratory~~ considered to be the most severe.

Tests are considered satisfactory when the enclosure has suffered neither damage nor permanent deformation liable to weaken any of its parts. In addition, joints shall have not been permanently enlarged at any point.

14.1.1 Determination of explosion pressure (reference pressure)

The reference pressure is the maximum value of the maximum smoothed pressure relative to atmospheric pressure observed during these tests.

> **NOTE** – One way to achieve a smoothed pressure signal is by inserting a 5 kHz ± 10 percent low pass filter in the pressure signal circuit.

The test consists of igniting an explosive mixture inside the enclosure and of measuring the pressure developed with the gaps within the limits of manufacturing tolerances indicated in the descriptive documents. Table IV indicates the number of tests and the range of explosive mixtures to be used, in volumetric ratio with air and at atmospheric pressure.

The mixture shall be ignited by one or more high-voltage sparking plugs or other low-energy source of ignition. Alternatively, where the enclosure contains a switching device that produces sparks capable of igniting the explosive mixture, then this shall preferably be used to initiate the explosion. The pressure developed during the explosion shall be measured and recorded in the course of each test. The siting of the plug or plugs, and of the pressure gauge or gauges, is left to the discretion of the testing laboratory. Pressure gauges and plugs are to be located as necessary to attempt to maximize explosion pressure considering the potential effects of pressure piling. In multiple compartment enclosures, at least one pressure gauge shall be located in each compartment.

Group IIC electrical apparatus intended to be used in a single specified gas may be tested in accordance with the requirements of Table IV.

When detachable gaskets are specified by the manufacturer, these shall be fitted to the electrical apparatus under test.

Rotating electrical machines shall be tested at rest and running. Both tests may not be necessary ~~as determined by the testing laboratory~~. When tested running, the operating power to the machine may be on or off but the test shall be carried out at a speed ~~equal to~~ of 90 percent to 100 percent of ~~or very close to~~ the maximum rated speed.

The pressure shall be measured at the ignition end, at the opposite end and at any position where excessive pressures are to be expected as a result of the enclosure design.

a) Apparatus compartments having provisions for connection to trade size 1-1/2 and smaller conduit shall be tested with the lengths of conduit specified in Table V if the compartment does not contain components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions. This apparatus may be marked in accordance with sub-clause 12.4 (Conduit Seal Not Required).

   EXCEPTION 1: Apparatus marked in accordance with paragraph 12.2 that requires seal fittings be attached on installation at 0.5 m or less and tested accordingly.

   EXCEPTION 2: Apparatus overpressure tested in accordance with sub-clause 14.1.2.1 using the values shown in Table VI.

b) If lengths of conduit are required to be connected to the apparatus for the maximum pressure effects, the conduit shall be used for inlet or outlet connection to the line carrying the explosive mixtures. A spark plug shall be located in the conduit length approximately 100 mm from the outer end.

c) Apparatus having a factory installed seal shall be subjected to explosion pressure tests on each side of the seal. Lengths of conduit, as specified in Table V, shall be connected to the conduit side of the seal. This apparatus shall be marked "Factory Sealed" in accordance with 12.3.

   EXCEPTION: The hydrostatic pressure tests specified in Table VI may be substituted for the explosion tests.

d) Apparatus compartments having provisions for connection to trade size 2 and larger conduit shall be tested with a 0.5 m length of conduit. A spark plug shall be located near the end of the conduit length.

EXCEPTION: Apparatus marked in accordance with paragraph 12.2 that requires seal fittings be attached on installation at less than 0.5 m and tested accordingly.

e) Apparatus compartments containing components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions shall be tested with a 0.5 m length of conduit. A spark plug shall be located near the end of the conduit length.

EXCEPTION: Apparatus marked in accordance with paragraph 12.2 that requires seal fittings be attached on installation at less than 0.5 m and tested accordingly.

14.1.2 Overpressure test

This test shall be made by one of the following methods, which are considered to be equivalent.

14.1.2.1 Static test

The pressure shall be equal to 1.5 times the reference pressure, with a minimum of 3.5 bar. The period of application of the pressure shall be at least 10 seconds but need not exceed 60 seconds:

~~$10^{+2}_{-0}s$~~

For enclosures of volume more than 10 cm^3 which are not subjected to the routine tests (see Clause 15), the test pressure shall be four times the reference pressure.

Apparatus not subjected to reference pressure tests as described by 14.1.1 (a) Exception 2, the overpressure tests shall be conducted at the values shown in Table VI.

~~If the reference pressure cannot be measured because the enclosure is too small, and if a dynamic method is not practicable, a static test shall be made with a relative pressure of:~~

~~10 bar - for Groups I, IIA, IIB~~
~~15 bar - for Group IIC~~

When reference pressure determination has been impractical and the compartment is not for connection to conduit, a static test shall be conducted based on the following:

Volume (cm^3)	Group	Pressure (bar)
≤ 10	IIA, IIB, IIC	10
>10	IIA, IIB	15
>10	**IIC**	**20**

NOTE – Static tests may be carried out on the enclosures or parts of enclosures. The conditions of tests should be agreed between the manufacturer and the testing laboratory.

The static test is carried out once.

14.1.2.2 Dynamic test

If the reference pressure is known, the dynamic test is made so that the maximum pressure to which the enclosure is subjected is 1.5 times the reference pressure. The rate of rise of pressure shall approximate ~~be not too different from~~ that obtained during the determination of the reference pressure. In particular, the test can be made by precompressing the explosive mixture used for the determination of the reference pressure.

If the determination of the reference pressure is not practicable (e.g. if the volume is too small or the pressure appears abnormal), the test is made by filling the enclosure with the explosive mixture specified in Table IV at a pressure of 1.5 times the atmospheric pressure. The dynamic test shall be carried out once, except that for Group IIC enclosures, the test shall be made three times with each explosive test mixture.

14.2 Tests for non-transmission of an internal ignition

The enclosure shall be placed in a test chamber. The test shall be made with the same explosive mixture inside the enclosure and in the test chamber.

The mixture inside the enclosure shall be ignited by means of a high-voltage sparking plug, or other low-energy source of ignition. Alternatively, where the enclosure contains a switching device that produces sparks capable of igniting the explosive mixture, then this may be used to initiate the explosion.

Gaskets which do not contribute to the explosion protection shall be removed.

The test result is considered satisfactory if ignition is not transmitted to the test chamber.

14.2.1 Enclosures for Groups ~~I,~~ IIA and IIB

The explosive mixtures to be used, in volumetric ratio with air, are given in Table IV.

14.2.1.1 The enclosure tested in its normal condition without creating an artificial gap (the joints being within the manufacturing tolerances indicated in the descriptive documents). In equation form:

$$0.8\ i_C \leq i_E \leq i_C \leq i_T$$

where:

i_C = the maximum constructional gap, as specified in the manufacturer's drawings

i_E = the test gap

i_T = the maximum gap permitted in Tables ~~I,~~ IIA or IIB.

14.2.1.2 If enclosures of Groups IIA and IIB could be destroyed or damaged by this test, ~~however,~~ it is permitted that the test be made by increasing the gaps above the maximum values specified by the manufacturer. The enlargement factor of the gap is 1.42 for Group IIA electrical apparatus and 1.85 for Group IIB electrical apparatus. The length of thread engagement for threaded joints ~~conforming to ISO fit~~ shall be reduced by ~~one-third with respect to that specified by the manufacturer and joints where the fit is worse than ISO by~~ one-half. Taper-threaded joints shall not be reduced.

The explosive mixtures to be used in the enclosure and in the test chamber, in volumetric ratio with air and at atmospheric pressure, are as follows:

- electrical apparatus of Group IIA: (4.2 ± 0.1) percent propane
- electrical apparatus of Group IIB: (6.5 ± 0.5) percent ethylene or (19 ± 1) percent hydrogen-methane (85/15) mixture

14.2.2 Enclosures for Group IIC

One of the following methods shall be used:

14.2.2.1 First method

The gaps of flanged joints, cylindrical joints, bearings and operating rods shall be increased to the value of:

— either:
$i_E = i_C + ½\ i_C$ with a minimum of 0.1 mm for flanged joints

— or:
$i_E = i_C + ½\ i_T$ for cylindrical joints
$i_E = 1.5\ i_T$ for flanged joints

where:

i_E = the test gap

i_C = the maximum constructional gap, as specified on the manufacturer's drawings

i_T = the maximum gap permitted in Table IIC.

The length of thread engagement for threaded joints ~~conforming to ISO fit~~ shall be reduced by ~~one-third with respect to that specified by the manufacturer and joints where the fit is worse than ISO, by~~ one-half. Taper-threaded joints shall not be reduced.

The enclosure and the test chamber are filled with one of the explosive mixtures indicated in Table IV at atmospheric pressure.

14.2.2.2 Second method

The enclosure shall be tested in its normal condition without creating an artificial gap. The gap shall be:

$$0.8\ i_C \le i_E \le i_C \le i_T$$

The enclosure and the test chamber are filled with one of the explosive mixtures indicated in Table IV at a pressure of 1.5 times the atmospheric pressure.

NOTES—

1) A gap less than 0.8 i_C may be tested provided that the test mixture pressure is proportionally increased to compensate for the lower value. The test pressure may be calculated from the following formula:

Test pressure = i_C/i_E x 1.2 x atmospheric pressure.

~~2) The volume ratio of the test chamber to the enclosure should be at least 5 to 1.~~

~~**14.2.2.3** For electrical apparatus of which only one specimen or a few specimens are to be constructed, each specimen shall be tested five times with one of the mixtures of the first method at atmospheric pressure, the joints being within the manufacturing tolerances.~~

14.3 Air Leakage Test -A factory-installed flameproof seal shall not permit the passage of more than 0.20 L per hour at a pressure of 150 mm of water across the seal. The test shall be conducted with wires sealed in place, using the maximum number and size of wires and wire insulation for which the seal is intended.

15 Routine tests

15.1 Routine tests are pressure tests carried out in accordance with one of the methods described in 14.1.2 for prototypes and samples. ~~For such tests, the method of the test shall be subject to agreement between the testing laboratory and the manufacturer.~~

For a routine test, it is sufficient to test empty enclosures. Each of the parts forming the enclosure may be tested separately with similar stressing compared to the complete enclosure.

~~However, if the routine test is dynamic, and if the enclosed apparatus influences the rise of pressure during an internal explosion, then agreement shall be reached between the manufacturer and the testing laboratory to define the conditions of the tests.~~

Routine tests are not required for enclosures with a volume less than or equal to 10 cm^3. This exception also applies to enclosures with a volume greater than 10 cm^3 when the specified type test has been made at a static pressure of four times the reference pressure. ~~Enclosures of welded construction are in every case submitted to the routine test.~~

NOTE – The procedures indicated above for the alternative routine test are intended to ensure that the enclosure withstands the pressure and also that it contains no holes or cracks reducing the flameproof properties of the enclosure or any part of it.

15.2 When the dynamic method given in 14.1.2.2 is chosen, the routine test consists of:

- either an explosion test with, inside and outside enclosure, the appropriate explosive mixture specified in Table IV at 1.5 times the atmospheric pressure
- or an explosion test with, inside and outside the enclosure, the explosive mixture specified in 14.2 at atmospheric pressure, preceded by one or other of the dynamic tests described in 14.1.2.2 for type tests;
- or a static test at a pressure of at least 2 bar, preceded by one or other of the dynamic tests described in 14.1.2.2 for type tests.

~~**15.3** If the reference pressure was not measured because the enclosure is too small, and if a dynamic method is not practicable, a static test shall be made with a relative pressure of:~~

~~10 bar - for Group I, IIA, or IIB~~
~~15 bar - for Group IIC~~

If the reference pressure was not measured and the compartment is not for connection to conduit, a static test shall be conducted based on the following:

Volume (cm^3)	Group	Pressure (bar)
≤ 10	IIA, IIB, IIC	10
>10	IIA, IIB	15
>10	IIC	20

NOTE – Static tests may be carried out on the enclosures or parts of enclosures. ~~The conditions of tests should be agreed between the manufacturer and the testing laboratory~~

15.4 The tests shall be considered satisfactory if the enclosure has not suffered structural damage or permanent deformation that may affect its flameproof properties.

TABLE I - Group I enclosures, minimum width of joint and maximum gap [1]

Width of joint, L (mm)	Maximum gap for volume of enclosure, V (cm^3) [2] (mm)	
	V ≤ 100	V < 100
Flanged and spigot joints		
6 ≤ L < 12.5	0.30	-
12.5 ≤ L < 25	0.40	0.40
25 ≤ L	0.50	0.50
Operating rods and spindles [3]		
6 ≤ L < 12.5	0.30	-
12.5 ≤ L < 25	0.40	0.40
25 ≤ L	0.50	0.50
Shafts with sleeve bearings [4]		
6 ≤ L < 12.5	0.30	-
12.5 ≤ L < 25	0.40	0.40
25 ≤ L < 40	0.50	0.50
40 ≤ L	0.60	0.60
Shafts with rolling element bearings [5]		
6 ≤ L < 12.5	0.450 [6]	-
12.5 ≤ L < 18.75	0.60 [6]	0.60 [6]
18.75 ≤ L < 25	0.60	0.60
25 ≤ L	0.750	0.750

1) In addition to the values given in this table, the values given in Table IIA, IIB and IIC may be used for Group I enclosures.

2) For rods, spindles and shafts, the gap is the maximum diametral clearance.

3) See 5.2 if the diameter of the operating rod or spindle is greater than the minimum width of joint specified here.

4) See 6.1 if the diameter of the shaft is greater that the minimum width of joint specified here.

5) The radial clearance shall not exceed the diametral clearance allowed for sleeve bearings (see 6.2).

6) Not permitted in some countries

TABLE IIA – Group IIA enclosures, minimum width of joint and maximum gap[1)]

Width of joint, L (mm)	Maximum gap for volume of enclosure, V (cm^3) [2)] (mm)		
	V ≤ 100	100 < V ≤ 2,000	V > 2,000
Flanged and spigot joints [3)]			
6 ≤ L < 9.5	0.30	-	-
9.5 ≤ L 12.5	0.30	-	-
12.5 ≤ L < 25	0.30	0.30	0.20
25 ≤ L	0.40	0.40	0.40
Operating rods and spindles [4)]			
6 ≤ L < 12.5	0.30	-	-
12.5 ≤ L < 25	0.30	0.30	0.20
25 ≤ L	0.40	0.40	0.40
Shafts with sleeve bearings [5)]			
6 ≤ L < 12.5	0.30	-	-
12.5 ≤ L < 25	0.35	0.30	0.20
25 ≤ L < 40	0.40	0.40	0.40
40 ≤ L	0.50	0.50	0.50
Shafts with rolling element bearings [6)]			
6 ≤ L < 12.5	0.45	-	-
12.5 ≤ L < 25	0.50	0.45	0.30
25 ≤ L < 40	0.60	0.60	0.60
40 ≤ L	0.75	0.75	0.75

1) In addition to the values given in this table, the values given in Tables IIB and IIC may be used for Group IIA enclosures.

2) For rods, spindles and shafts, the gap is the maximum diametral clearance.

3) For L ≥ 9.5 mm and gap ≤ 0.040 mm up to 5,800 cm^3 only for flanged joints and no volume restriction for other joints.

4) See 5.2 if the diameter of the operating rod or spindle is greater than the minimum width of joint specified here.

5) See 6.1 if the diameter of the shaft is greater than the minimum width of joint specified here.

6) The radial clearance shall not exceed the diametral clearance allowed for sleeve bearings (see 6.2).

TABLE IIB – Group IIB enclosures, minimum width of joint and maximum gap[1)]

Width of joint, L (mm)	Maximum gap for volume of enclosure, V (cm^3) [2)] (mm)		
	V ≤ 100	100 < V ≤ 2,000	V > 2,000
Flanged and spigot joints [3)]			
6 ≤ L < 9.5	0.20	-	-
9.5 ≤ L 12.5	0.20	-	-
12.5 ≤ L < 25	0.20	0.20	0.15
25 ≤ L	0.20	0.20	0.20
Operating rods and spindles [4)]			
6 ≤ L < 12.5	0.20	-	-
12.5 ≤ L < 25	0.20	0.20	0.15
25 ≤ L	0.20	0.20	0.20
Shafts with sleeve bearings [5)]			
6 ≤ L < 12.5	0.20	-	-
12.5 ≤ L < 25	0.25	0.20	0.15
25 ≤ L < 40	0.30	0.25	0.20
40 ≤ L	0.40	0.30	0.25
Shafts with rolling element bearings [6)]			
6 ≤ L < 12.5	0.30	-	-
12.5 ≤ L < 25	0.40	0.30	0.20
25 ≤ L < 40	0.45	0.40	0.30
40 ≤ L	0.60	0.45	0.40

1) In addition to the values given in this table, the values given in Table IIC may be used for Group IIB enclosures.

2) For rods, spindles and shafts, the gap is the maximum diametral clearance.

3) For L ≥ 9.5 mm and gap ≤ 0.040 mm to 5,800 cm^3 only for flanged joints and no volume restriction for other joints.

4) See 5.2 if the diameter of the operating rod or spindle is greater than the minimum width of joint specified here.

5) See 6.1 if the diameter of the shaft is greater than the minimum width of joint specified here.

6) The radial clearance shall not exceed the diametral clearance allowed for sleeve bearings (see 6.2).

Table IIC – Group IIC enclosures, minimum width of joint and maximum gap

Width of joint, L (mm)	Maximum gap for volume of enclosure, V (cm^3) [2] (mm)				
	V ≤ 100	100 < V ≤ 500	500 < V ≤ 1,500	1,500 < V ≤ 2,000	V > 2,000
Flanged joints [2]					
6 ≤ L < 9.5	0.10	-	-	-	-
9.5 ≤ L 15.8	0.10	0.10	-	-	-
15.8 ≤ L < 25	0.10	0.10	0.04	-	-
25 ≤ L	0.10	0.10	0.04	0.04	0.04
Spigot joints [3]					
6 ≤ L < 12.5	0.10	0.10	-	-	-
12.5 ≤ L < 25	0.15	0.15	0.15	0.15	-
25 ≤ L < 40	0.15	0.15	0.15	0.15	0.15
40 ≤ L	0.20	0.20	0.20	0.20	0.20
Spigot joints (figure 4) C ≥ 6 mm d min = 0.5 L L = C + d f ≤ 1 mm					
12.5 ≤ L < 25	0.15	0.15	0.15	0.15	-
25 ≤ L < 40 [4]	0.18	0.18	0.18	0.18	0.18
40 ≤ L [5]	0.20	0.20	0.20	0.20	0.20
Cylindrical joint operating rod or spindles [6]					
6 ≤ L < 9.5	0.10	-	-	-	-
9.5 ≤ L < 12.5	0.10	0.10	-	-	-
12.5 ≤ L < 25	0.15	0.15	0.15	0.15	-
25 ≤ L < 40	0.15	0.15	0.15	0.15	0.15
40 ≤ L	0.20	0.20	0.20	0.20	0.20
Cylindrical joint for shaft glands of rotating electrical machines with rolling element bearing					
6 ≤ L < 9.5	0.15	-	-	-	-
9.5 ≤ L < 12.5	0.15	0.15	-	-	-
12.5 ≤ L < 25	0.25	0.25	0.25	0.25	-
25 ≤ L < 40	0.25	0.25	0.25	0.25	0.25
40 ≤ L	0.30	0.30	0.30	0.30	0.30

~~1) Enclosures of volume larger than 6000 cm^3 and with any one dimension larger than 1 m are subject to special requirements upon which agreement should be reached between the manufacturer and the testing laboratory.~~

2) Flanged joints are not permitted for explosive mixtures of acetylene and air except if the gap ≤ 0.040 mm for L ≥ 9.5 mm up to 500 cm^3.

3) For gap ≤ 0.040 mm up to 6000 cm^3 is permitted and for diametral clearance of cylindrical parts, this value may be 0.060 mm.

4) iT of cylindrical part increased to 0.20 if f ≤ 0.5 mm.

5) iT of cylindrical part increased to 0.25 if f ≤ 0.5 mm.

6) ~~Special attention is drawn to the requirements relating to wear, given in Clause 5.~~ See 5.2 if the diameter of the operating rod or spindle is greater than the minimum width of joint specified here.

Table III – Threaded Joints

Threaded joints shall comply with the following:

-either:

Pitch1) ~~Class of fit 2)~~ ~~(ISO 965-1 and 965-3)~~	0.7 ≤ pitch ≤ 3 mm (36 tpi > pitch>8.5 tpi) ~~medium: 0.7 < pitch < 2 mm~~ ~~fine: 2 < pitch < 3 mm~~
Threads engaged3)	≥ 5
Enclosure volume Enclosures ≤ 100 cm3 Enclosures > 100 cm3	Length of engagement: ≥ 5 mm ≥ 8 mm

-or:

Pitch	≥ 1.27 mm (≤ 20 tpi)
Threads engaged	≥ 5 tapered threads ≥ 6 parallel threads 5H4h (UN Class 3 per ANSI B2.10) ≥ 7 parallel threads 6H6g (UN Class 2 per ANSI B2.10) ≥ 8 parallel threads 7H8g (UN Class 1 per ANSI B2.10)

NOTES—

1) Where the pitch exceeds 2 mm, special precautions may be necessary to ensure that the electrical apparatus can pass the test for non-transmission of an internal ignition specified in 14.2.

~~2) Cylindrical threaded joints which do not conform with the ISO standard are permitted if the test for non-transmission of an internal ignition specified in 14.2 is passed.~~

3) Difficulties may be encountered in achieving the five thread engagement for tapered threads when using standard gauging practice.

Table IV – Explosion Tests

Enclosure	Determination of explosion pressure (Reference pressure)		Test to determine whether the enclosure is flameproof	
	Number of tests	Explosive Test Mixture4)	Number of tests	Explosive test mixture
~~Group I~~	~~3~~	~~Methane (CH_4) (9.8 ± 0.5)%~~	~~5~~[2])	~~Methane (CH_4) Hydrogen (H_2) (58 ± 1)% CH_4 (42 ± 1)% H_2 (12.5 ± 0.5)% MESG = 0.8 mm~~
Group IIA	~~3~~ 10	Propane (C_3H_8) ~~(4.6±0.3)%~~ (3 - 7)%	5[3])	Hydrogen (H_2) (55 ± 1) % MESG = 0.65 mm
Group IIB	~~3~~ 10[1])	Ethylene (C_2H_4) ~~(8.0 ± 0.5) %~~ (4 - 9)%	5[3])	Hydrogen (H_2) (37 ± 1.0)% MESG = 0.35 mm
Group IIC2)	~~5~~ 10	Hydrogen (H_2) ~~(31± 1.0)%~~ (15 - 35)%	5	Hydrogen (H_2) (27 ± 1.0)%
	~~5~~ 10	Acetylene (C_2H_2) ~~(14.0 ± 0.5)%~~ (5 - 20)%	5	Acetylene (C_2H_2) (7.5 ± 1)%

1) In cases where pressure piling may occur, the test shall be made at least ~~five(5)~~ ten (10) times and repeated at least ~~five~~ ten times with a mixture of (24 ±1) percent hydrogen-methane [(85± 1)% H_2, (15 ± 1)% CH_4] with air. There is presumption of pressure piling when either the pressure values obtained during a series of tests deviate from one to another by a factor of ≥ 1.5 or the pressure rise time is less than 5 ms.

2) If the enclosure is marked for use only in hydrogen or in acetylene, ~~five~~ tests shall be made for the specified gas only.

3) The explosive mixtures chosen for this test include a known margin of safety. This margin of safety, K, is the ratio of the maximum experimental safe gap (MESG) of the most incendive mixture of the group concerned (see IEC 79-1A) to the maximum experimental safe gap of the chosen explosive test mixture:

~~**Group I: $K = \frac{1.14}{0.8} = 1.42$**~~

Group IIA: $K = \frac{0.92}{0.65} = 1.42$

Group IIB $K = \frac{0.65}{0.35} = 1.85$

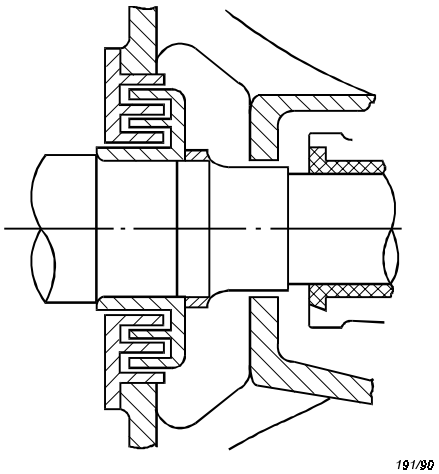
4) Where a range of explosive test mixtures is shown for the reference pressure determination, the number of tests indicated shall be conducted at mixtures approximately equally spaced throughout the indicated range.

Tables V & VI are added material

Table V – Lengths of Rigid Metal Conduit for Explosion Tests		
Group	Conduit Trade Size	Conduit Length
IIC, IIB	Less than 2	5, 10, and 15 Feet (1.5, 3, & 4.5 m)
IIA	Less than 2	2 Feet (0.6 m)

TABLE VI – Hydrostatic Pressures for Factory-installed Seals

Conduit Trade Size	REQUIRED HYDROSTATIC PRESSURE		
	Group IIC	Group IIB	Group IIA
1/2 thru 2	414 bar	83 bar	41 bar
2-1/2 thru 6	276 bar	83 bar	41 bar



NOTE – A labyrinth gland in which the length of the tortuous path or the clearance between the component parts is not in accordance with Table~~s I or~~ II may be acceptable if it can be shown to satisfy the test requirement of Section Two (see ~~4.1~~ 4.6).

Figure 1 - Example of a Labyrinth gland suitable for both sleeve bearings and rolling-element bearings (see 4.6)

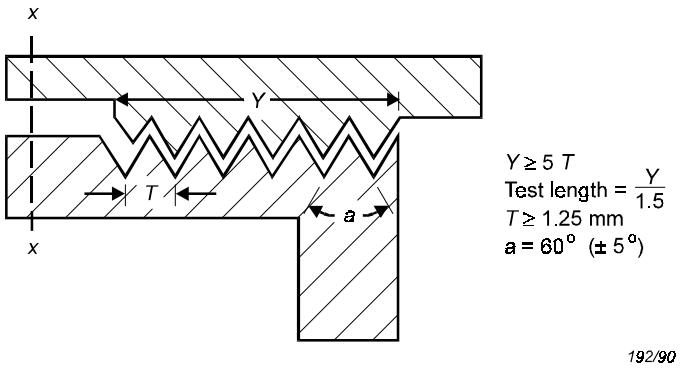


Figure 2– Example of serrated joint (see 4.7)

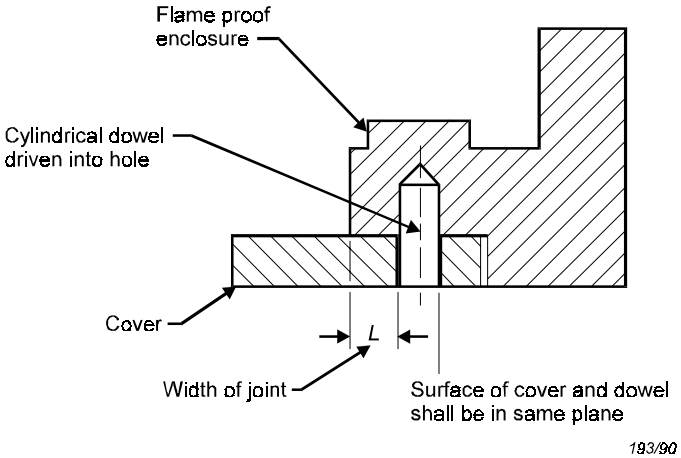
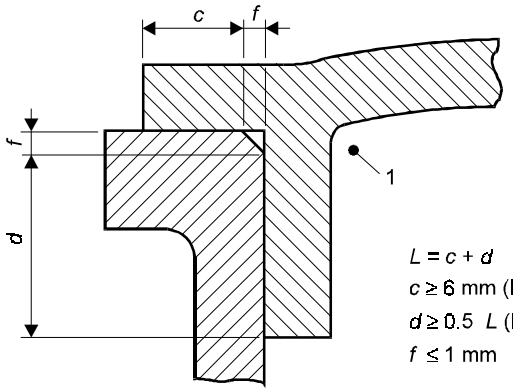
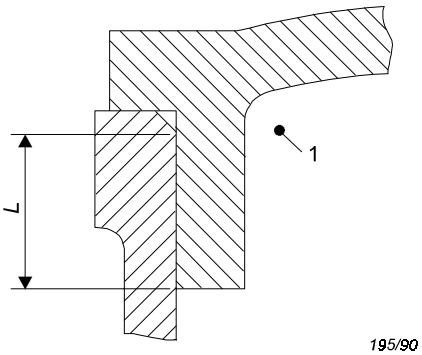


Figure 3 – Example of indirect checking of the gap of a flameproof joint (see 4.2.3)



194/90



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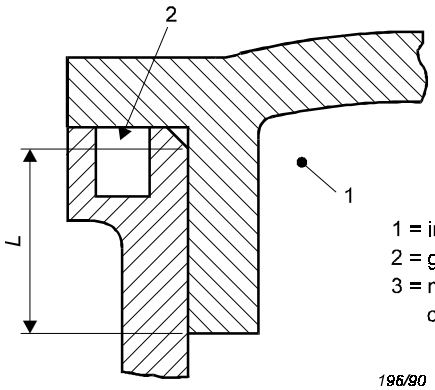

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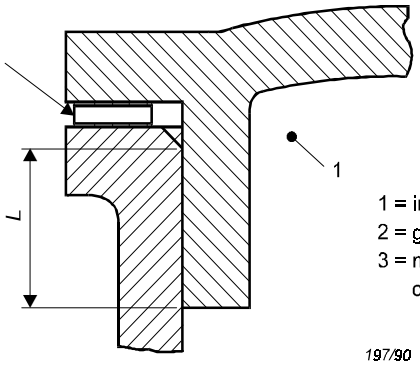
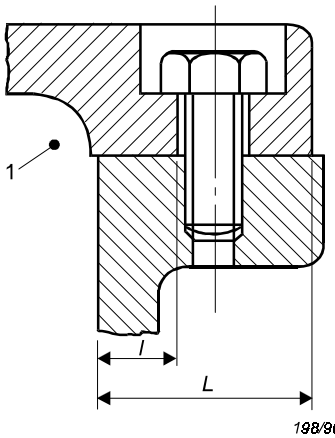


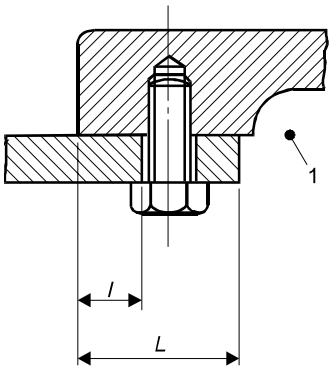
1 = interior of enclosure
2 = gasket
3 = metal or metal clad
compressible gasket

197/90



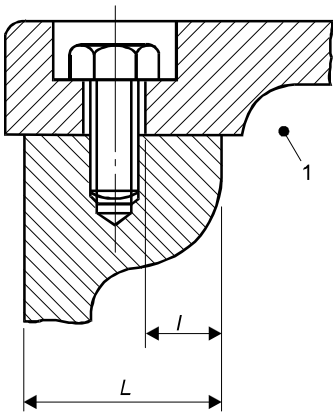
198/90

1 = interior of enclosure

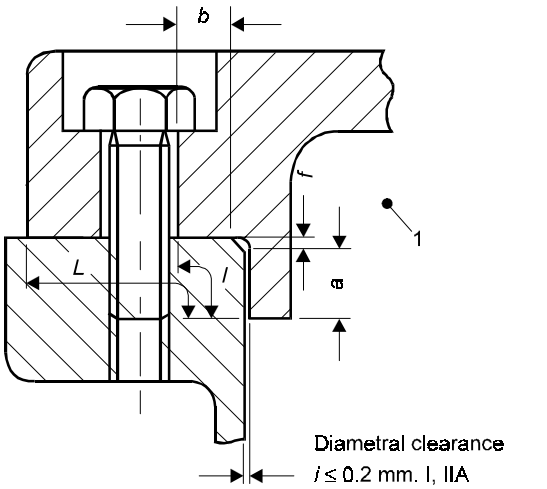


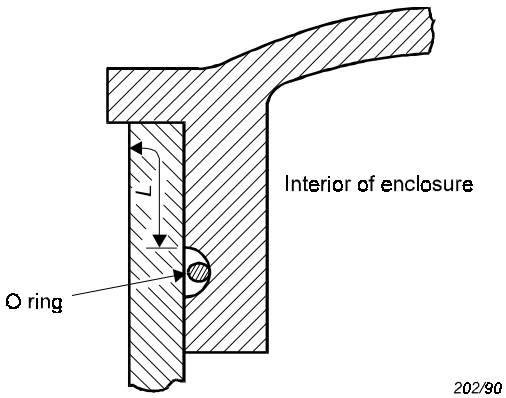
1 = interior of enclosure

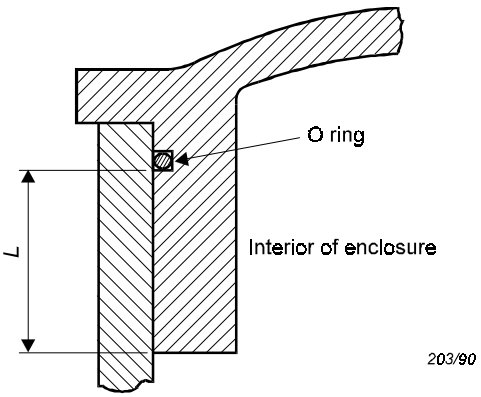
199/90



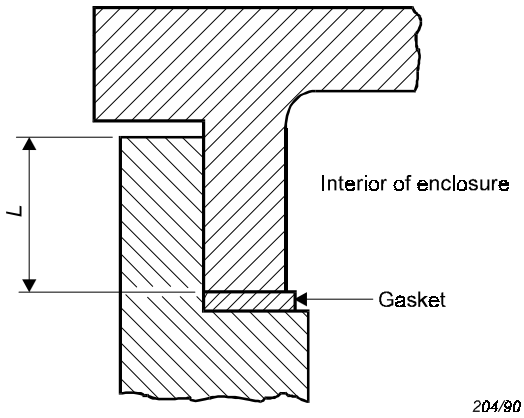
200/90

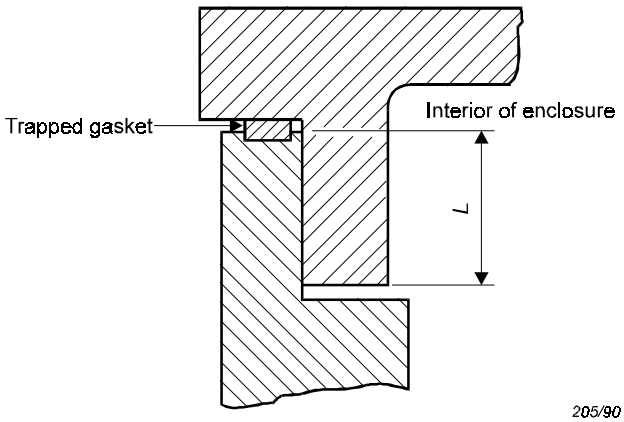




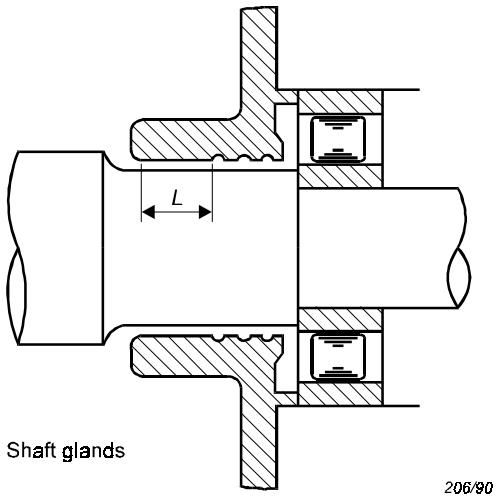


L = width of joint (see Tables I and II)

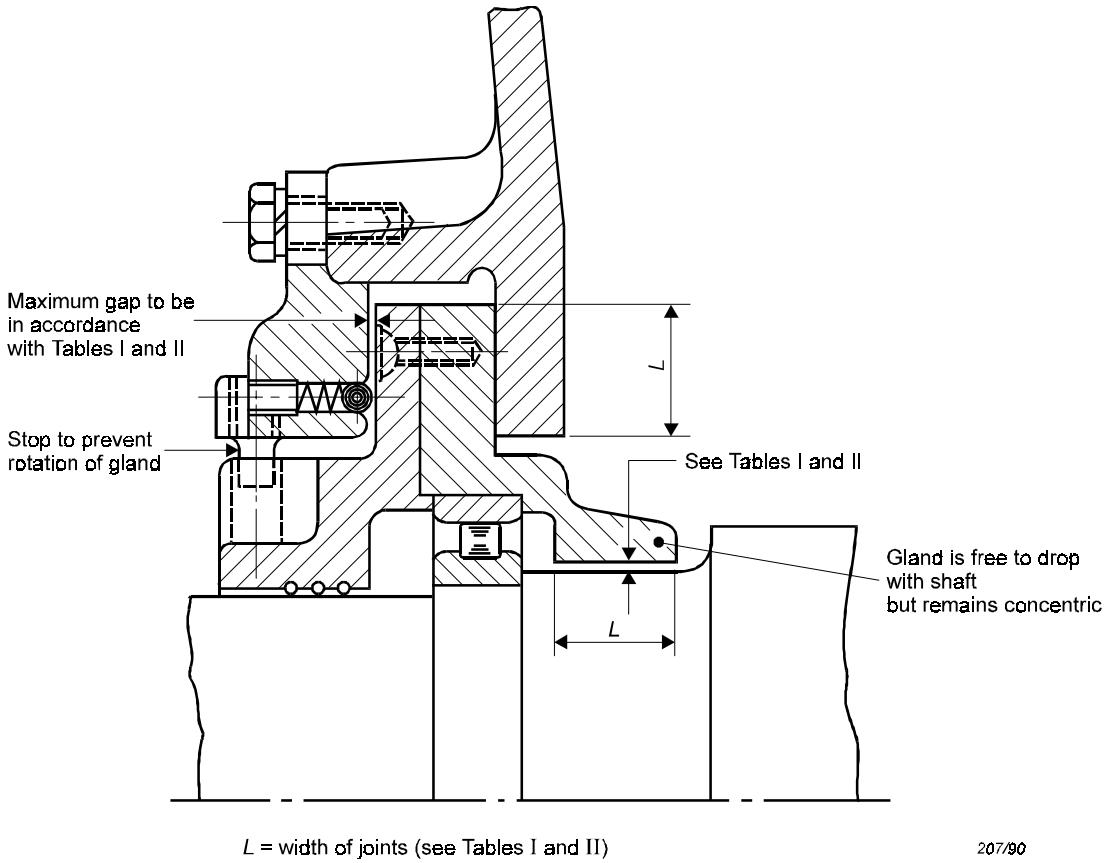




L = width of joint (see Tables I and II)



L = width of joint (see Tables I and II)



NOTE - The degree of float provided for in the design should take into account the air gap between the stator and rotor and the permissible wear in the bearings.

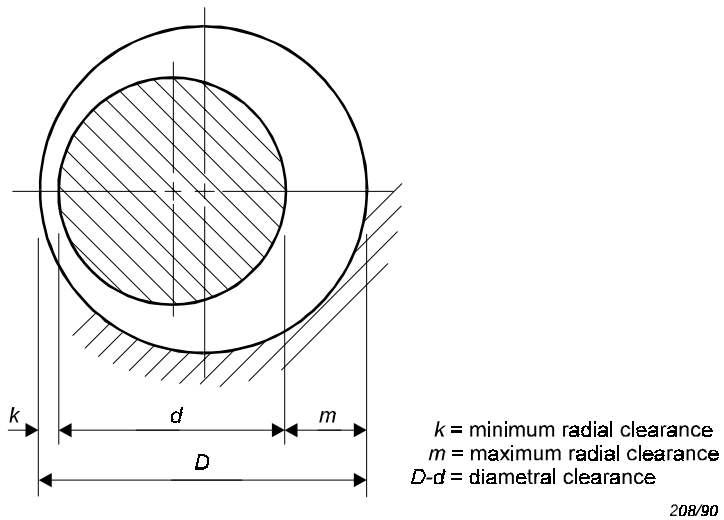
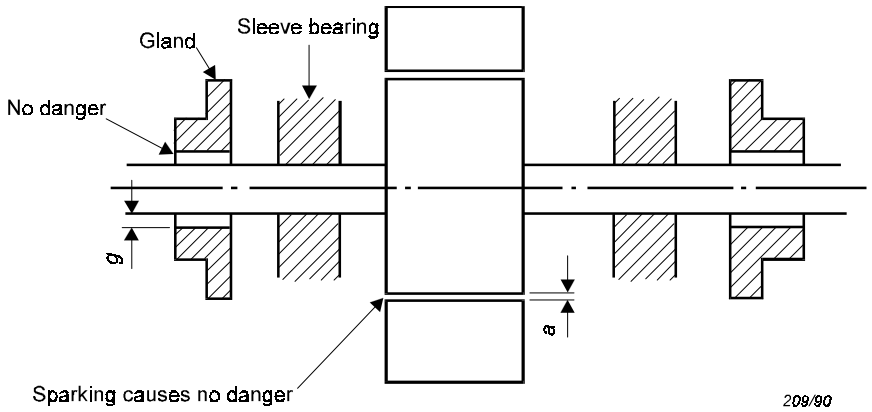
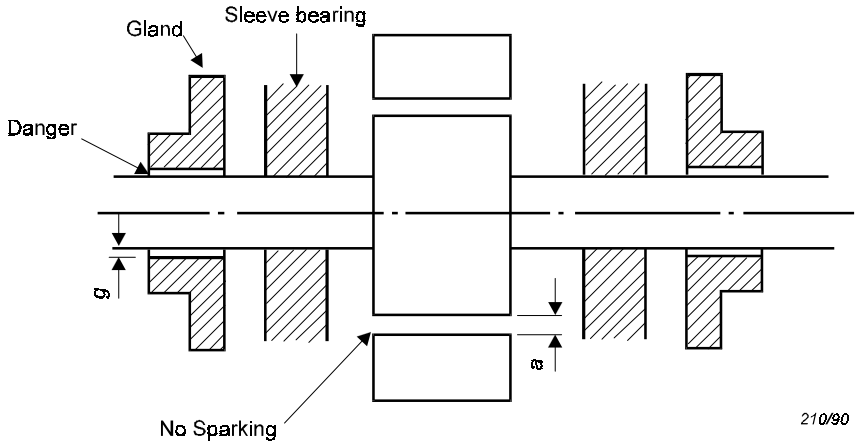


Figure 18 – Joints of shaft glands of rotating electrical machines





a = radial clearance between rotor and stator

g = radial movement permitted by gland

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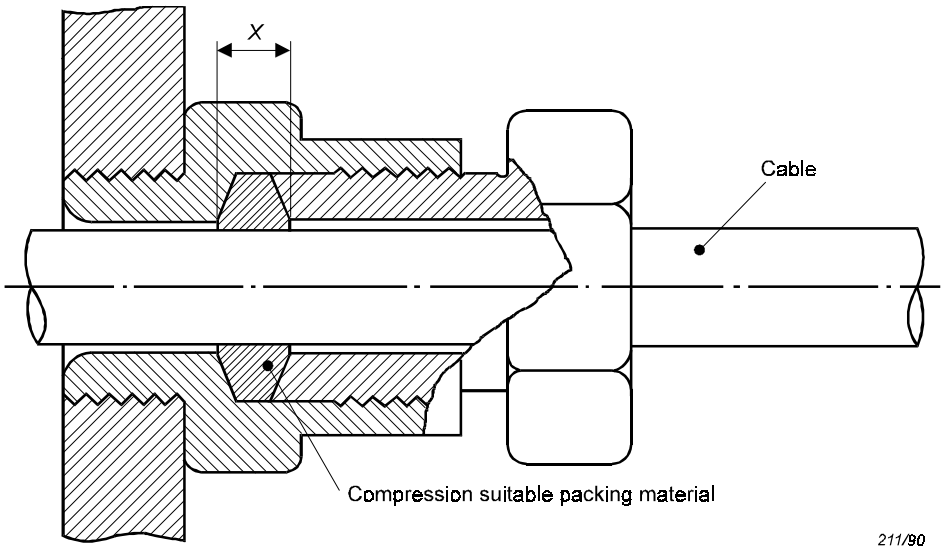
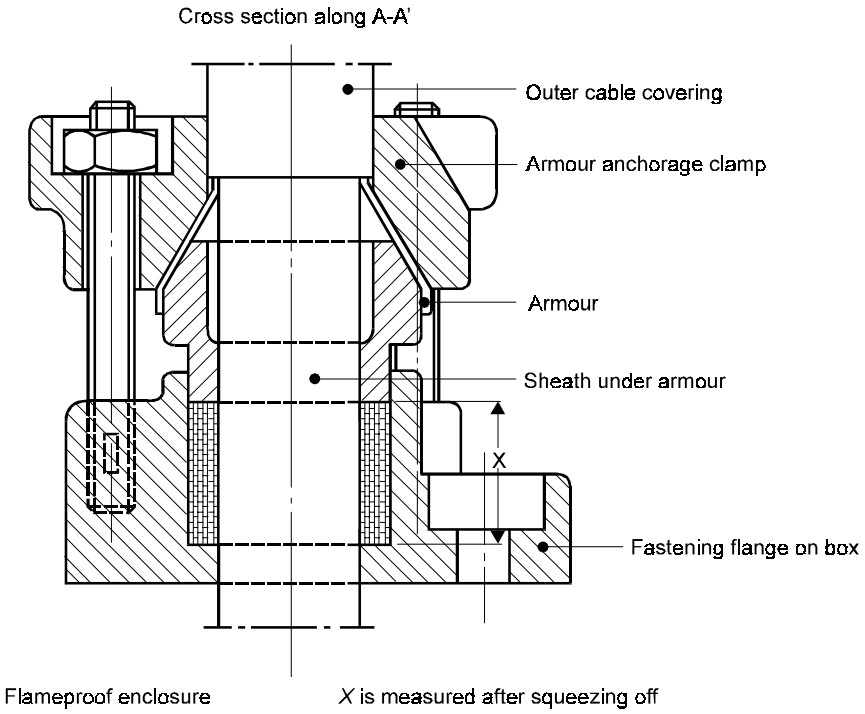


X = width of seal

NOTE - The figure illustrates requirements of 11.4 but does not purport to show actual constructional details; the width of seal *X* is measured with the packing material compressed.

Figure 21 – Example of direct cable entry
DELETE

FIGURE DELETED



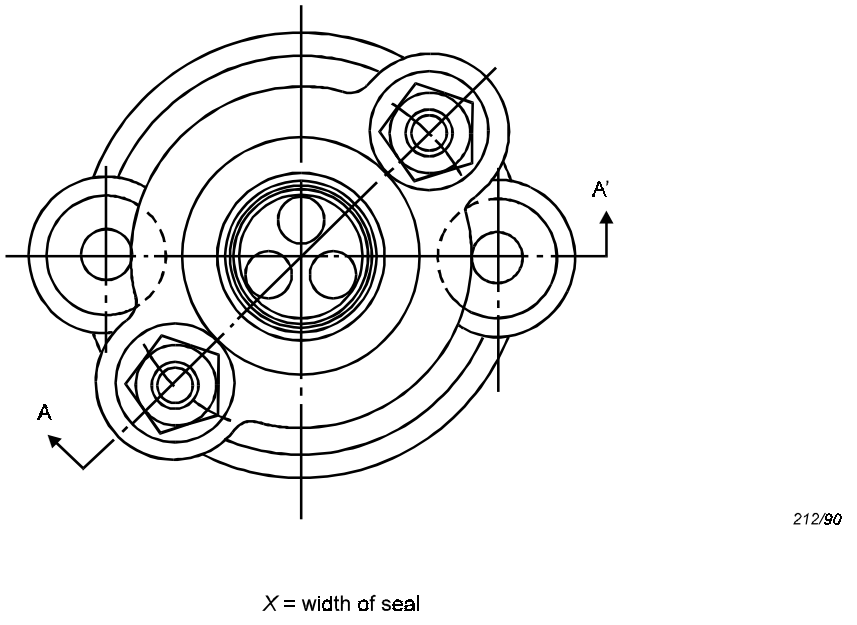


Figure 22 – Example of flameproof cable entry for armored cable (with armor anchorage device). (See 11.4)
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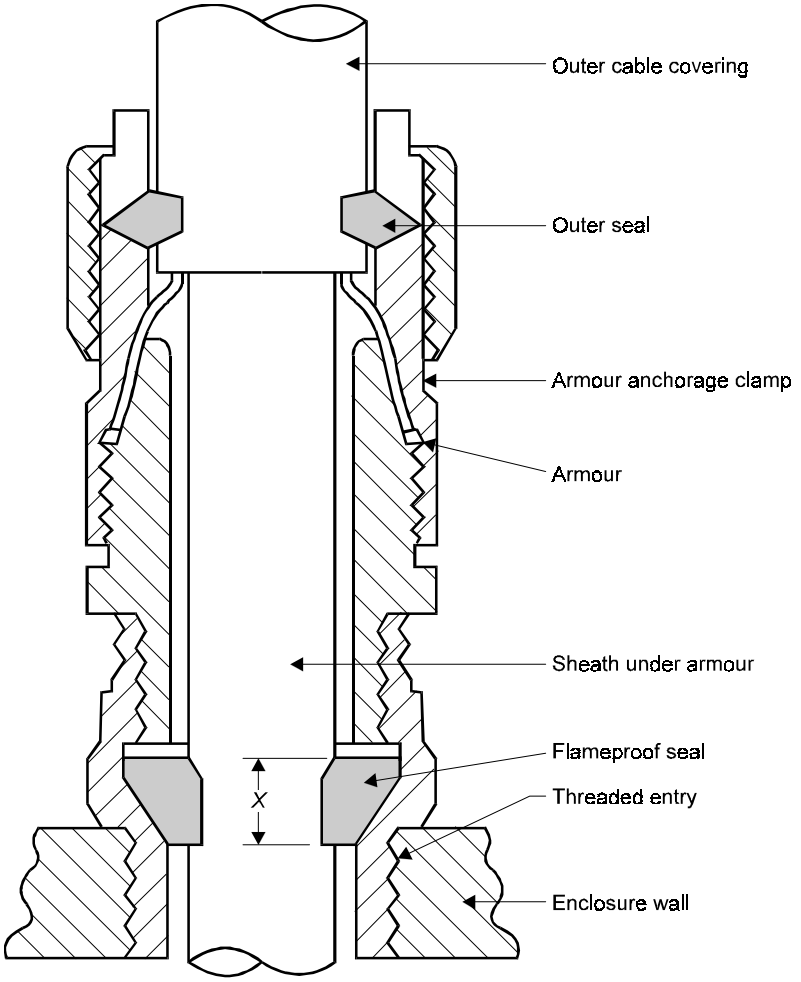
FIGURE DELETED



X = width of seal

Figure 23 – Example of flameproof direct cable for armored cable (with armored anchorage device)
(See 11.4)

Annex A (Normative) – Non-metallic parts of flameproof enclosures

A.1 Scope

This annex applies to non-metallic enclosures and non-metallic parts of enclosures except for:

- ~~sealing rings of cable entries and~~
- non-metallic parts on which this ~~the~~ type of protection does not depend.

A.2 Special constructional requirements

A.2.1 Resistance to tracking and creepage distances on internal surfaces of the enclosure walls

When an enclosure or part of an enclosure of non-metallic material serves directly to support live bare parts, the resistance to tracking and the creepage distances on the internal surfaces of the walls of the enclosure or part of an enclosure shall comply with the requirements of ~~IEC 79-7~~ ISA-S12.16.01 (IEC 79-7 Mod).

~~However, for flameproof enclosures of Group I, insulating materials subjected to electrical stresses capable of causing arcs in air and which result from rated currents or more than 16 A (in switching apparatus such as circuit breakers, contactors, isolators) shall have a comparative tracking index (CTI) equal to or greater than 400 M, according to IEC 112.~~

A.3 Supplementary requirements for type tests

A.3.1 General

A.3.1.1 Ambient temperature during tests

When some tests have to be made at ambient temperatures different from the ambient temperature existing where tests are made, these ambient temperatures shall be:

- for the upper ambient temperature, the maximum ambient temperature in service (see 1.2) increased by at least 10 K ~~but at most 15 K~~.
- for the lower ambient temperature, the minimum ambient temperature in service (see 1.2) reduced by at least 5 K ~~but at most 10 K~~.

A.3.1.2 Sequence of tests

~~Electrical apparatus of Group I~~

~~The test shall be made on six samples:~~

- ~~Two samples shall be submitted to the tests of thermal endurance to heat (A3.1.3), then the tests of thermal endurance to cold (A3.1.4), then to the mechanical tests of IEC 79-0 and finally to the tests for flameproofness(A3.2) and the tests for flammability (A.3.3).~~

- ~~Two samples shall be submitted to the tests of resistance to oils and greases (A.3.1.6) then to the mechanical tests of IEC 79-0 and finally to the tests for flameproofness (A.3.2) and the tests for flammability (A.3.3).;~~

- ~~Two samples shall be submitted to the tests for resistance to hydraulic liquids for mining applications (A3.1.6) then to the mechanical tests of IEC 79-0 and finally to the tests for flameproofness(A3.2) and the tests for flammability (A3.3).~~

Electrical apparatus of Group II

The tests shall be made on two samples which shall be submitted to the tests of thermal endurance to heat (A.3.1.3), then to tests of thermal endurance to cold (A.3.1.4) then to the mechanical tests of ISA-S12.0.01 (IEC 79-0 Mod) IEC 79-0 and finally to the tests of flameproofness (4.2) and the tests for flammability (A.3.3).

A.3.1.3 Thermal endurance to heat

The thermal endurance to heat is determined by submitting the enclosures or parts of enclosures made of plastic materials on which the integrity of the type of protection depends to continuous storage for four weeks in an ambient relative humidity of (90 ± 5) percent relative humidity and at a temperature (20 ± 2)°C 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 (95 ± 2)°C and (90 ± 5) percent relative humidity followed by a period of two weeks at a temperature (20 ± 2)°C higher than the maximum service temperature with the prevailing ambient humidity within the test chamber.

A.3.1.4 Thermal endurance to cold

The thermal endurance to cold is determined by submitting the enclosures and parts of enclosures made of polymeric plastic material on which the type of protection depends to storage for 24 hours in an ambient corresponding to the minimum service temperature reduced as specific in A.3.1.1.

A.3.1.5 Resistance to light

Resistance to light is an ordinary location requirement and is covered by ANSI/UL 746C (Ref S12.0.01 (IEC 79-0 Mod) sub-clause 1.4).

~~A test of resistance of the material to light shall be made only if the enclosure or parts of enclosures made of plastic material are not protected from light. For electrical apparatus of Group I, the test applies only to luminaires.~~

The test shall be made on six test bars of standard size 50 mm x 6 mm x 4 mm according to ISO179. The test bars are to be made under the same conditions as those used for the manufacture of the enclosure concerned. These conditions are to be stated in the test report of 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 ± 3)°C. The exposure time shall be 1,000 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 percent of the corresponding value measured on the unexposed test pieces. For materials whose impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more that three of the exposed test bars may break.

A3.1.6 Resistance to chemical agents for Group I Electrical apparatus

The polymeric plastic enclosures and polymeric plastic parts of enclosures shall be submitted to tests of resistance to the following chemical agents:

- oils and greases
- hydraulic liquids for mining applications.

The relevant tests shall be made on four samples of enclosures sealed against the intrusion of test liquids into the interior of the enclosure.

- Two samples shall remain for (24±2) h in oil No. 2 according to the annex dealing with "reference immersion liquids" of ISO Standard 1817, at a temperature of 50° C.
- Two other samples shall remain for (24± 2) h in a hydraulic liquid of aqueous solution of ethylene glycol in 35% water by volume.
- At the end of the test, the enclosure samples concerned shall be removed from the liquid bath, carefully wiped and then stored for 24 hours in the laboratory atmosphere. Subsequently, each of the enclosure samples shall pass the mechanical tests specified in IEC 79-0.
- If one or more of the enclosure samples do not withstand these mechanical tests, special conditions for safe use shall be stated in the certificate and the marking of the electrical apparatus shall include the symbol X according to IEC 79-0.

A.3.1.7 Resistance to chemical agents for Group II

Under consideration

A.3.2 Tests for flameproofness

A.3.2.1 The tests for flameproofness shall be made in the following order on the enclosures which have been previously subjected, as far as these tests are applicable, to the tests of A.3.1.

A.3.2.2 Tests of ability of the enclosure to withstand pressure

These tests shall be made as specified in 14.1 of ISA-S12.22.01 (IEC 79-1 Mod) ~~IEC 79-1~~.

A.3.2.3 Tests of erosion by flame

This test shall be made on enclosures on which the flameproof joints have at least one face of polymeric plastic material.

Exception: If the volume is less than 100 cm^3 and the material passes the flammability test according to A.3.3.1, then the erosion test is not necessary.

For this test:

- static gaps of flanged joints and plane parts of spigot joints by the enclosure shall be set to a value between 0.1 mm to 0.15 mm; however, if the maximum permitted static gap for the Group under consideration is less than 0.15 mm, the gaps shall be set to the maximum permitted value;

- cylindrical joints and cylindrical parts of spigot joints, as well as threaded joints, shall not be modified.

- for bushings which are common to two adjacent flameproof enclosures, the test shall be carried out in the enclosure giving the worst conditions.

The test consists of 50 ignitions of the explosive mixture specified in 14.1.1 of ISA-S12.22.01 (IEC 79-1 Mod) ~~IEC 79-1~~ for the corresponding Group (for electrical apparatus of Group IIC, 25 ignitions of each of the two explosive mixtures specified).

It is judged satisfactory if the following test for non-transmission is satisfactory.

A.3.2.4 Test for non-transmission of an internal ignition

This test shall be made as specified in 14.2 of ISA-S12.22.01 (IEC 79-1 Mod) ~~IEC 79-1~~.

A.3.3 Flammability

A.3.3.1 This test shall be carried out in accordance with ISO 1210.

The test pieces shall be:

- cut from the enclosure of the electrical apparatus, or

- molded as individual pieces, or
- cut from plates prepared for this purpose.

The test pieces molded as individual pieces or the plates from which the test pieces are cut shall be produced under the conditions as close as possible to those used to produce the enclosures of the electrical apparatus. These conditions shall be recorded in the manufacturer's documentation.

NOTE – If the conditions under which the enclosures are produced are critical, this should be recorded in the certification documents.

The time during which the test piece continues to burn after removal of the flame shall be less than 15 s. During this time, the test piece shall not be burnt completely (ISO 1210).

A.3.3.2 If the test in A.3.3.1 is not applicable due to distortion of the test piece out of flame, one of the following alternative tests shall be applied.

A.3.3.3.1 First alternative method

The test shall be carried out in accordance with IEC 707 (Method FV: Flame - Vertical specimen).

The test pieces shall be:

- cut from the enclosure of the electrical apparatus, or
- molded as individual pieces, or
- cut from plates prepared for this purpose.

The test pieces molded as individual pieces or the plates from which the test pieces are cut shall be produced under conditions as close as possible to those used to produce the enclosures of the electrical apparatus. These conditions shall be recorded in the manufacturer's documentation.

A.3.3.3.2 Second alternative method

The burning test is to be conducted in a chamber, enclosure or laboratory hood that is free from drafts. Each specimen is to be supported from the upper (6 mm) end of the specimen, with the longitudinal axis vertical, by the clamp on the ring stand so that the lower end of the specimen is 10 mm above the top of the burner tube and 300 mm above the horizontal layer of dry absorbent surgical cotton (50 mm x 50 mm swatch thinned to a maximum free standing thickness of 6 mm).

The Bunsen burner shall have a tube with a length of 100 mm and an inside diameter of 9.5 ± 0.5 mm. The tube shall not be equipped with end attachments such as stabilizers. The gas should be technical grade methane gas with suitable regulator and meter for uniform gas flow. (Natural gas having heat content of approximately 37 MJ per cubic meter has been found to provide

similar results). The test specimen shall be (125 ± 5) mm in length, (13 ± 0.3) mm in width, and (3.0 ± 0.2) mm in thickness. When necessary, the specimens shall be preconditioned (see 5.2 of ISO 1210).

The burner is to be placed remote from the specimen, ignited and adjusted to produce a blue flame 20 mm high. The flame should be obtained by adjusting the gas supply and the air ports of the burner until a 20 mm yellow-tipped blue flame is produced and then an increase in the air supply is to be made until the yellow tip disappears. The height of the flame is to be measured again and corrected if necessary. The test flame is to be placed centrally under the lower end of the test specimen and allowed to remain for 10 s. The test flame is then to be withdrawn at least 150 mm away and the duration of flaming of the specimen noted. When flaming of the specimen ceases, the test flame is to be immediately placed again under the specimen. After 10 s the test flame is again to be withdrawn, and the duration of flaming and glowing is to be noted.

The flammability properties of the tested material are acceptable when:

- no specimen burns with flaming combustion for more than 10 s after each application of the test flame;
- the total flaming combustion time does not exceed 50 s for the 10 flame applications for each set of three specimens;
- no specimen burns with flaming or glowing combustion up to the holding clamp;
- no specimen drips flaming particles that ignite the dry absorbent surgical cotton located 300 mm below the test specimen;
- no specimen burns with glowing combustion which persists beyond 30 s after the second removal of the test flame.

Annex B – Breathing and draining devices (Normative)

B.1 Scope

This annex applies to breathing devices and draining devices used in flameproof enclosures.

The following requirements apply equally to devices for the transmission of sound but do not cover devices for:

- relief of pressure in the event of internal explosion, or
- use with pressure lines containing gas which is capable of forming an explosive mixture with air and is at a pressure in excess of 1.1 times atmospheric pressure.

B.2 General requirements

Breathing or draining devices shall incorporate permeable elements which can withstand the pressure created by an internal explosion in the enclosure to which they are fitted, and which shall prevent the transmission of the explosion to the explosive atmosphere surrounding the enclosure.

They shall also withstand the dynamic effects of explosions within the flameproof enclosure without permanent distortion or damage which would impair their flame-arresting properties. They are not intended to withstand continuous burning on their surfaces.

The openings for breathing or draining shall not be produced by deliberate enlargement of gaps of flanged joints.

NOTE – A device could be designed for breathing, draining or both.

If for technical reasons, the breathing or draining devices have to be provided, the manufacturer shall supply instructions to the user that care shall be taken to ensure that the devices are not liable to become inoperative in service (e.g. because of the accumulation of dust or paint).

B.3 The composition limits of the materials used in the device shall be specified either directly or by reference to an existing applicable specification. The elements of breathing/draining devices for use with acetylene shall comprise not more than 60 percent of copper by mass to limit acetylide formation.

B.4 The dimensions of the breathing and draining devices and their component parts shall be specified.

B.5 Elements with measurable paths

Interstices and measurable lengths of path need not comply with the values given in Tables ~~I,~~ IIA, IIB, or IIC provided that the elements pass the tests of Clause B.11.

B.6 Additional requirements for crimped ribbon elements of breathing and draining devices

B.6.1 Crimped ribbon elements shall be constructed from cupronickel, stainless steel or other material investigated and found suitable for the purpose ~~a metal agreed between the manufacturer and the testing station~~. Aluminum, titanium, magnesium and their alloys shall not be used.

B.6.2 Where the path through the device can be specified in the drawings and can be measured in the complete device, an upper and lower tolerance limit for the path dimensions shall be specified and shall be monitored in production.

B.6.3 Where B.6.2 does not apply, the requirements of B.7.2 shall apply.

B.6.4 The type of tests of 14.2 shall be carried out with samples manufactured with the largest permitted gap dimensions.

B.7 Elements with non-measurable paths

Where the paths through the elements are not measurable (for example, sintered metal elements), the element shall comply with the relevant requirements of B.7.1 and B.7.2. The elements are classified according to their density as well as their pore size.

For functional reasons, it can also be necessary to state the fluid permeability and the porosity.

B.7.1 Where appropriate the manufacturer shall specify:

- the element density
- the maximum pore size
- the fluid permeability
- the porosity

in accordance with a recognized standard method for the particular material and the particular manufacturing method.

B.7.2 Additional requirements for elements, with non-measurable paths, of breathing and draining devices

B.7.2.1 Sintered metal elements

B.7.2.1.1 Sintered metal elements shall be constructed from the following:

- stainless steel, or
- 90/10 copper-tin or bronze, or
- other material investigated and found suitable for the purpose ~~a specific metal or specific alloy agreed between the manufacturer and the testing station~~.

B.7.2.1.2. The equivalent bubble pressure pore size shall be determined by the method specified in ISO 4003.

B.7.2.1.3 The density of the sintered metal element shall be determined in accordance with ISO 2738.

B.7.2.1.4 Where determination of open porosity and/or fluid permeability of elements is required in connection with functional aspects of devices, measurements shall be made in accordance with ISO 4022 and ISO 2738.

B.7.2.1.5 Sintered metal elements shall be clearly identified in the documentation by declaring:

- the material in accordance with B.3 and B.7.2.1.1;
- the maximum bubble test pore size in µm in accordance with B.7.2.1.2;
- the density in accordance with B.7.2.1.3;
- the minimum thickness;
- where appropriate the fluid permeability and open porosity in accordance with B.7.2.1.4.

B.7.2.2 Pressed metal wire elements

B.7.2.2.1 Pressed metal wire elements shall be constructed from stainless steel wire or other material investigated and found suitable for the purpose ~~another specified metal agreed between~~

~~the manufacturer and the testing station~~. The elements shall be rigid and have defined dimensions.

~~NOTE – Manufacture starts from a wire braid which is compressed into a die to form a homogeneous matrix.~~

B.7.2.2.2 In order to evaluate the density, the wire diameter shall be specified. Information shall also be given on the mass, length of wire braid and mesh size. The ratio between the mass of the filter and the mass of an identical volume of the same solid metal shall be between 0.4 and 0.6.

B.7.2.2.3 The equivalent bubble pressure pore size shall be determined by the method specified in ISO 4003.

B.7.2.2.4 The density of the element shall be determined in accordance with ISO 2738.

B.7.2.2.5 Where determination of open porosity and/or fluid permeability is required in connection with functional aspects of elements, measurements shall be made in accordance with ISO 4022 and ISO 2738.

B.7.2.2.6 Elements shall be clearly identified in the documentation by declaring:

- the material in accordance with B.3 and B.7.2.2.1;
- the maximum bubble test pore size in µm in accordance with B.7.2.2.3;
- the density in accordance with B.7.2.2.4;
- the dimensions, including tolerances;
- the original wire diameter;
- where appropriate, the fluid permeability and open porosity in accordance with B.7.2.2.5.

B.7.2.3 Metal foam elements

B.7.2.3.1 Elements shall be produced by coating a reticulated polyurethane foam with nickel, removing polyurethane by thermal decomposition and converting the nickel into a nickel-chrome alloy e.g., by gaseous diffusion, and compressing the material as necessary.

B.7.2.3.2 Metal foam elements shall contain at least 15 percent chromium by mass.

B.7.2.3.3 The equivalent bubble test pore size shall be determined by the method specified in ISO 4003.

B.7.2.3.4 The density of the element shall be determined in accordance with ISO 2738.

B.7.2.3.5 Where the determination of open porosity and/or fluid permeability is required in connection with functional aspects of elements, measurements shall be made in accordance with ISO 2738 and ISO 4022.

B.7.2.3.6 Metal foam elements shall be clearly defined in the documentation by declaring:

- the material, in accordance with B.7.2.3.1 and B.7.2.3.2;
- the maximum bubble test pore size in µm in accordance with B.7.2.3.3;
- the minimum thickness;
- the minimum density;
- where appropriate, the open porosity and fluid permeability in accordance with B.7.2.3.5.

B.8 If a device can be dismantled, it shall be designed to avoid reduction or enlargement of the openings during re-assembly.

B.9 Mounting arrangements of the elements

The breathing and draining elements shall be sintered, welded or brazed, or cemented in accordance with 4.5, or fixed by other suitable methods:

- either directly into the enclosure to form an integral part of the enclosure;
- or in a suitable mounting component, which is clamped or screwed into the enclosure so that it is replaceable as a unit.

Alternatively, the element can be mounted so as to form a flameproof joint. In this case, the appropriate requirements of Clause 4 are to be applied, with the exception that the surface roughness of the element need not comply with 4.2.2 if the element arrangement passes the type test in Section Three. If necessary, a clamping ring or similar means can be used to maintain the integrity of the enclosure. The breathing or draining element can be mounted either:

- from within, in which case the accessibility of screws and clamping rings shall be possible only from the inside;
- or from outside the enclosure, in which case the fasteners shall comply with Clause 9.

B.10 Mechanical strength

The device and its guard, if any, shall, when mounted normally, pass the impact test of ISA-S12.0.01 (IEC 79-0 Mod) ~~IEC 79-0~~.

B.11 Tests of flameproof enclosure with breathing and draining devices

The tests in accordance with B.11.1 to B.11.3 shall be carried out in the following order on a sample after the impact of strength test of Clause B.10.

For devices with non-measurable paths, the pore size of the sample shall not be less than 85 percent of the specified maximum pore size.

B.11.1 Test of ability of the enclosure to withstand pressure

The test shall be made in accordance with 14.1 with the following additions and modifications.

B.11.1.1 For the determination of the explosion pressure in accordance with 14.1.1, breathing and draining devices shall be replaced by solid plugs.

B.11.1.2 For the over pressure test in accordance with 14.1.2 a thin flexible membrane (e.g. a thin polymeric ~~plastic~~ sheet) is fitted to the inner surfaces of the breathing and draining devices. After the over pressure test, the device shall show no permanent deformation or damage affecting the type protection.

B.11.2 Thermal tests

B.11.2.1 Test procedure

The enclosure with the device or devices fitted shall be tested in accordance with B.11.3.1 but with the ignition source only in the position giving the most unfavourable results.

The temperature of the external surface of the device or devices shall be monitored during the tests. The tests shall be made five times. The test mixture to be used shall be (4.2 ± 0.1) percent propane in volumetric ratio with air and at atmospheric pressure and additionally, for devices intended for use in acetylene, a mixture of (7.5 ± 1) percent acetylene in volumetric ratio with air and at atmospheric pressure shall be used.

In an enclosure where there is the possibility of a forced or induced flow of a potentially dangerous gas, the enclosure shall be arranged during the tests so that the gas can flow through the device(s) and the enclosure.

Any ventilation or sampling system shall be operated as specified in the manufacturer's documentation. After each of the five tests the explosive mixture shall be maintained for a sufficient time to allow any continuous burning on the face of the device to become evident (e.g., for at least 10 minutes so as to increase the temperature of the external surface of the device or to make temperature transfer to the outer face possible).

B.11.2.2 Acceptance criteria

No flame transmission shall occur. No continuous burning shall be observed.

The measured external surface temperature rise of the device shall be multiplied by a safety factor of 1.2 for the determination of the temperature class of the electrical apparatus.

B.11.3 Test for non-transmission of an internal ignition

This test shall be made in accordance with 14.2 with the following additions and modifications.

B.11.3.1 Test procedure

An ignition source shall be placed first close to the inner surface of the breathing and draining device and subsequently, when necessary, in one or more places which produce the highest peak explosion pressure and rate of rise of pressure at the face of the device. Where the enclosure has more than one identical device, the device to be tested shall be that which gives the most unfavourable results. The gas mixture within the enclosure shall be ignited. The test shall be made five times for each position of the ignition source.

B.11.3.2 For breathing and draining devices of groups ~~I,~~ IIA, and IIB, the non-transmission test of 14.2.1 shall be applied.

For breathing and draining devices of group IIC with measurable paths, 14.2.2 and either B.11.3.2.1 or B.11.3.2.2 are to be applied.

For breathing and draining devices of group IIC with non-measurable paths, B.11.3.2.1 or B.11.3.2.2 is to be applied.

B.11.3.2.1 Method A

For devices for hydrogen only, only the test with the hydrogen/air mixture is required. The tests are made five times with 1.5 bar precompression.

B.11.3.2.2 Method B

The use of this method involves limitation of the range of group IIC gases covered. Where exclusion of a specific gas or gases is required, the apparatus shall be provided with specific installation instructions or reference to a specific installation document ~~marked with an 'X'~~.

Ethyl nitrate is excluded.

Carbon disulfide is excluded for enclosures with a volume greater than 100 cm^3.

The gas mixtures to be used for the enclosure and the test chamber consist of the following, in volumetric ratio and at atmospheric pressure:

a) (40 ± 1) percent hydrogen, (20 ± 1) percent oxygen and the rest nitrogen;

b) (10 ± 1) percent acetylene, (24 ± 1) percent oxygen and the rest nitrogen.

For hydrogen, only gas mixture a) is to be used.

These test procedures are being considered again by the ad hoc working group set up in Brisbane to study the requirements for component certification of breathing and draining devices.

ANNEX C (Informative) — U. S. major deviations

NOTE—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” or “WARNING” 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.

4.1 Note 1 Special joints are permitted. The note was deleted and mandatory text was added to address the construction requirements for these joints in Clauses 4.6 and 4.7.

4.6 Requirements added for labyrinth joints. See 4.1 above.

4.7 Requirements added for serrated joints. See 4.1 above.

5.4 This clause was deleted because the standard does not address wear, and the present clause is unenforceable.

11.2 Changes were made to this clause to align with the NEC conduit wiring method.

11.3.2 This clause was deleted since this construction does not comply with the NEC.

11.4 Changes were made to align with the NEC requirements concerning the sealing provisions for the conduit wiring method.

12 All of the changes concerning the marking requirements were made to align with the NEC and the use of conduit systems.

14 The second paragraph was added and changes to 14.1.1 including the exceptions were made to align with the NEC. The requirements address the pressure concerns of flameproof enclosures used with conduit systems.

14.1.2.1 The existing vague text was replaced with the new text from the second edition of EN50 018.

14.2.1.2 Changes reflect a uniform reduction of threaded joints.

14.2.2.1 Changes reflect a uniform reduction of threaded joints.

14.3 This clause was added to reflect U.S. practice concerning seals.

15.1 Routine testing is not the U.S. practice for welded enclosures.

15.3 The existing vague text was replaced with the new text from the second edition of EN50 018.

Table IV Ranges of gas mixtures were added to accommodate the U.S. practice to determine suitability of flameproof enclosures used as part of a conduit system.

Table V Same as Table IV above.

Table VI Same as Table IV above.

A.3.1.1 Text revised to permit testing of low thermal mass samples while still achieving the intended results.

A.3.1.5 Resistance to light is an ordinary location requirement and is covered by ANSI/UL 746C, and is a requirement of S12.0.01 (IEC 79-0 Mod) sub-clause 1.4.

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