

INTERNATIONAL STANDARD

IEC
60079-1

Fourth edition
2001-02

Electrical apparatus for explosive gas atmospheres –

Part 1: Flameproof enclosures "d"

Matériel électrique pour atmosphères explosives gazeuses –

*Partie 1:
Enveloppe antideflagrante «d»*



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**ELECTRICAL APPARATUS FOR EXPLOSIVE GAS AMOSPHERES –
Part 1: Flameproof enclosures "d"**

INTERPRETATION SHEET

This interpretation sheet has been prepared by IEC technical committee 31: Electrical apparatus for explosive atmospheres.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
31/655/ISH	31/665/RVD

Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

Subclause 8.2.2 – Rolling element bearings

It is understood that, with assemblies, all parts will not exist at the worst case dimensions simultaneously. Also a statistical treatment of the tolerances, such as "RMS", may be required for m and k verification.

Furthermore, it is understood that it is not a requirement of this standard that the manufacturer's m and k calculations be verified. Also, it is not a requirement of this standard that m and k be verified by measurement.

Subclauses 15.2.1.1, 15.2.2.1 and 15.2.2.2:

When preparing a test sample employing a cylindrical joint of a shaft gland for a rotating machine with roller element bearings, it is understood that the test gap i_E is based on the diametrical clearance from Table 1 or Table 2, and not the radial clearance of 8.2.2.

NOTE This clarification is being introduced in IEC 60079-1 Edition 6 and therefore an Interpretation Sheet will not be required for this or future editions.

**MATÉRIEL ÉLECTRIQUE POUR ATMOSPHÈRES ÉLECTRIQUES GAZEUSES –
Partie 1: Enveloppes antidéflagrantes «d»**

FEUILLE D'INTERPRÉTATION

Cette feuille d'interprétation a été établie par le comité d'études 31 de la CEI: Matériel électrique pour atmosphères explosives.

Le texte de cette feuille d'interprétation est issue des documents suivants:

ISH	Rapport de vote
31/655/ISH	31/665/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette feuille d'interprétation.

Paragraphe 8.2.2 – Eléments de roulement de palier

Il est reconnu que dans un assemblage, toutes les pièces ne sont simultanément pas à leurs dimensions les plus défavorables. Un traitement statistique des tolérances, comme la méthode de la valeur quadratique moyenne (RMS) peut être requis pour la vérification de m et k .

De plus il est admis que la présente norme n'exige pas que les calculs de m et de k du constructeur soient vérifiés. Cette norme n'exige pas non plus que m et k soient vérifiés par des mesures.

Paragraphes 15.2.1.1, 15.2.2.1 et 15.2.2.2 :

Lorsque l'on prépare un échantillon d'essai utilisant un joint cylindrique d'une traversée d'arbre pour une machine tournante avec des éléments de roulement de palier, l'interstice d'essai j_e est basé sur le jeu critique du diamètre du tableau 1 ou du tableau 2 et non sur la jeu radial de 8.2.2.

NOTE Cette clarification a été introduite dans l'édition 6 de la CEI 60079-1 et cette « Feuille d'interprétation » n'est donc pas nécessaire pour cette édition et les suivantes.

CONTENTS

	Page
FOREWORD	3
Clause	
1 Scope	5
2 Normative references	5
3 Definitions	6
4 Apparatus grouping and temperature classification	7
5 Flameproof joints	8
6 Cemented joints	17
7 Operating rods	17
8 Supplementary requirements for shafts and bearings	18
9 Light-transmitting parts	21
10 Breathing and draining devices which form part of a flameproof enclosure	21
11 Fasteners, associated holes and closing devices	26
12 Materials and mechanical strength of enclosures; materials inside the enclosures	28
13 Entries for flameproof enclosures	29
14 Verification and tests	31
15 Type tests	31
16 Routine tests	40
17 Switchgear for Group I	41
18 Lampholders and lampcaps	42
19 Non-metallic enclosures and non-metallic parts of enclosures	43
Annex A (normative) Additional requirements for crimped ribbon elements of breathing and draining devices	47
Annex B (normative) Additional requirements for elements, with non-measurable paths, of breathing and draining devices	48
Annex C (normative) Additional requirements for flameproof cable entries	50

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –**Part 1: Flameproof enclosures "d"**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 60079-1 has been prepared by subcommittee 31A: Flameproof enclosures, of IEC technical committee 31: Electrical apparatus for explosive atmospheres.

This fourth edition cancels and replaces the third edition published in 1990 and its amendments 1 (1993) and 2 (1998). This fourth edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
31A/89/FDIS	31A/91/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

This standard is to be read in conjunction with IEC 60079-0, the requirements of which apply to electrical apparatus with flameproof enclosures.

Annexes A, B and C form an integral part of this standard.

The committee has decided that the contents of this publication will remain unchanged until 2002-12. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of June 2001 have been included in this copy.

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Withdrawn

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

Part 1: Flameproof enclosures "d"

1 Scope

This part of IEC 60079 contains the specific requirements for the construction and testing of electrical apparatus with the type of protection flameproof enclosure "d", intended for use in potentially explosive gas atmospheres.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60079. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60079 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60061 (all parts), *Lamp caps and holders together with gauges for the control of interchangeability and safety*

IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-1A:1975, *Electrical apparatus for explosive gas atmospheres – Part 1: Construction and verification test of flameproof enclosures of electrical apparatus – First supplement: Appendix D: Method of test for ascertainment of maximum experimental safe gap*

IEC 60079-7:1990, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety "e"*

IEC 60079-11:1999, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety "i"*

IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60707:1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source*

ISO 31-0:1992, *Quantities and units – Part 0: General principles*

ISO 185:1988, *Grey cast iron – Classification*

ISO 965-1:1980, *ISO general-purpose metric screw threads – Tolerances – Part 1: Principles and basic data*

ISO 965-3:1980, *ISO general-purpose metric screw threads – Tolerances – Part 3: Deviations for constructional threads*

ISO 1210:1982, *Plastics – Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source*

ISO 2738:1987, *Permeable sintered metal materials – Determination of density, oil content, and open porosity*

ISO 4003:1977, *Permeable sintered metal materials – Determination of bubble test pore size*

ISO 4022:1987, *Permeable sintered metal materials – Determination of fluid permeability*

ISO 6892:1984, *Metallic materials – Tensile testing*

3 Definitions

For the purpose of this standard, the following definitions, in addition to those given in IEC 60079-0, apply.

3.1

flameproof enclosure "d"

an enclosure in which the parts which can ignite an explosive atmosphere are placed and which can withstand the pressure developed during an internal explosion of an explosive mixture, and which prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure

3.2

volume

total internal volume of the enclosure. However, for enclosures in which the contents are essential in service, the volume to be considered is the remaining free volume

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

3.3

flameproof joint

place where the corresponding surfaces of two parts of an enclosure come together, or the conjunction of enclosures, and which prevents the transmission of an internal explosion to the explosive atmosphere surrounding the enclosure

3.4

width of flameproof joint (L)

shortest path through a flameproof joint from the inside to the outside of an enclosure

3.5

distance (l)

shortest path through a flameproof joint, when the width of the joint L is interrupted by holes intended for the passage of fasteners for assembling the parts of the flameproof enclosure

3.6

gap of flameproof joint (l)

distance between the corresponding surfaces of a flameproof joint when the electrical apparatus enclosure has been assembled. For cylindrical surfaces, forming cylindrical joints, the gap is the difference between the diameters of the bore and the cylindrical component

3.7**maximum experimental safe gap (MESG) (for an explosive mixture)**

maximum gap of a joint of 25 mm in width which prevents any transmission of an explosion in 10 tests made under the conditions specified in IEC 60079-1A

3.8**shaft**

part of circular cross-section used for the transmission of rotary movement

3.9**operating rod**

part used for the transmission of control movements which may be rotary or linear or a combination of the two

3.10**pressure-piling**

results of an ignition, in a compartment or subdivision of an enclosure, of a gas mixture pre-compressed, for example, due to a primary ignition in another compartment or subdivision

3.11**quick-acting door or cover**

door or cover provided with a device which permits opening or closing by a simple operation, such as the movement of a lever or the rotation of a wheel. The device is arranged so that the operation has two stages:

- one for locking or unlocking;
- another for opening or closing

3.12**door or cover fixed by threaded fasteners**

door or cover, the opening or closing of which, requires the manipulation of one or more threaded fasteners (screws, studs, bolts or nuts)

3.13**threaded door or cover**

door or cover which is assembled to a flameproof enclosure by a threaded flameproof joint

3.14**breathing device**

integral or separable part of a flameproof enclosure designed to permit exchange between the atmosphere inside the enclosure and the surrounding atmosphere

3.15**draining device**

integral or separable part of a flameproof enclosure designed to permit water formed by condensation to escape from the enclosure

4 Apparatus grouping and temperature classification

The apparatus grouping and temperature classification defined in IEC 60079-0 for the use of electrical apparatus in potentially explosive atmospheres apply to flameproof enclosures. The subdivisions A, B, C for electrical apparatus of Group II also apply.

5 Flameproof joints

5.1 General requirements

All flameproof joints, whether permanently closed or designed to be opened from time to time, shall comply, in the absence of pressure, with the appropriate requirements of clause 5.

The design of joints shall be appropriate to the mechanical constraints applied to them.

NOTE The values given in clause 5 constitute the necessary conditions. Additional measures may be necessary in order to pass the non-transmission test of 15.2.

The surface of joints may be protected against corrosion.

Coating with paint or powder-coat finish is not permitted. Other coating material may be used if the material and application procedure have been shown not to adversely affect the flameproof properties of the joint.

5.2 Non-threaded joints

5.2.1 Width of joints (L)

The width of joints shall not be less than the minimum values given in tables 1 and 2. The width of joints for cylindrical metallic parts press-fitted into the walls of a metallic flameproof enclosure of a volume not greater than 2 000 cm³ may be reduced to 5 mm, if

- the design does not rely only on an interference fit to prevent the part being displaced during the type tests of clause 15, and
- the assembly meets the impact test requirements of IEC 60079-0, taking the worst-case interference fit tolerances into account, and
- the external diameter of the press-fitted part, where the width of the joint is measured, does not exceed 60 mm.

5.2.2 Gap (l)

The gap, if one exists, between the surfaces of a joint shall nowhere exceed the maximum values given in tables 1 and 2.

The surfaces of joints shall be such that their average roughness R_a (derived from ISO 468:1982, *Surface roughness – Parameters, their values and general rules for specifying requirements – withdrawn 1998*) does not exceed 6,3 μm .

For flanged joints there shall be no intentional gap between the surfaces, except for quick-acting doors or covers.

For electrical apparatus of Group I, it shall be possible to check, directly or indirectly, the gaps of flanged joints of covers and doors designed to be opened from time to time. Figure 1 shows an example of construction for indirect checking of a flameproof joint.

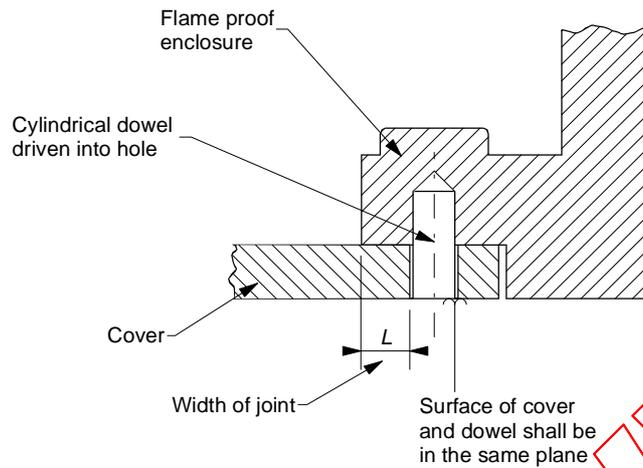


Figure 1 – Example of construction for indirect checking of a flanged Group I flameproof joint

5.2.3 Spigot joints

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

- either the cylindrical part and the plane part (see figure 2).
(The gap, if one exists, between the surfaces of the joint shall nowhere exceed the maximum values given in tables 1 and 2.)
- or the cylindrical part only (see figure 3),
(In this case the plane part need not comply with the requirements of tables 1 and 2.)

NOTE For gaskets see also 5.4.

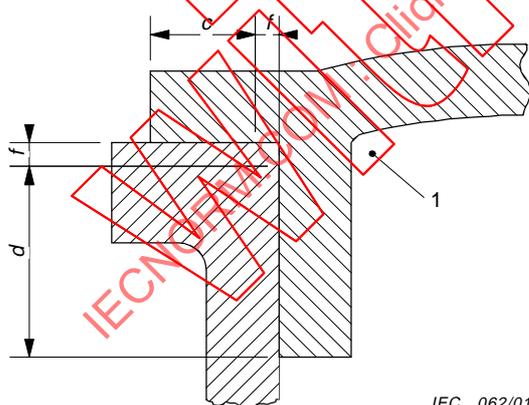


Figure 2

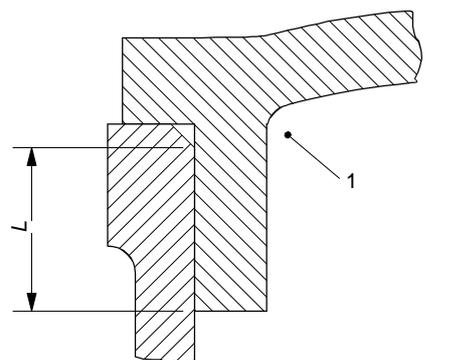


Figure 3

Key

$L = c + d$ (I, IIA, IIB, IIC)

$c \geq 6,0$ mm (IIC)

$\geq 3,0$ mm (I, IIA, IIB)

$d \geq 0,50 L$ (IIC)

$f \leq 1,0$ mm (I, IIA, IIB, IIC)

1 Interior of enclosure

Figures 2 and 3 – Spigot joints

5.2.4 Holes in joint surfaces

Where a plane joint or the plane part or partial cylindrical surface (see 5.2.6) of a joint is interrupted by holes intended for the passage of threaded fasteners for assembling the parts of a flameproof enclosure, the distance l to the edge of the hole shall be equal to or greater than

- 6 mm when the width of joint L is less than 12,5 mm;
- 8 mm when the width of joint L is equal to or greater than 12,5 mm but less than 25 mm;
- 9 mm when the width of joint L is equal to or greater than 25 mm.

The distance l is determined as follows.

5.2.4.1 Flanged joints with holes outside the enclosure (see figures 4 and 6)

The distance l is measured between each hole and the inside of the enclosure.

5.2.4.2 Flanged joints with holes inside the enclosure (see figure 5)

The distance l is measured between each hole and the outside of the enclosure.

5.2.4.3 Spigot joints where, to the edges of the holes, the joint consists of a cylindrical part and a plane part (see figure 7)

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 electrical apparatus of Groups I and IIA, 0,15 mm for electrical apparatus of Group IIB, or 0,1 mm for electrical apparatus of Group IIC (reduced gap);
- the width b of the plane part alone, if either of the above-mentioned conditions is not met.

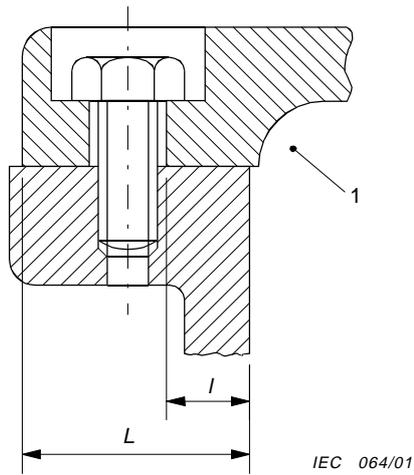


Figure 4

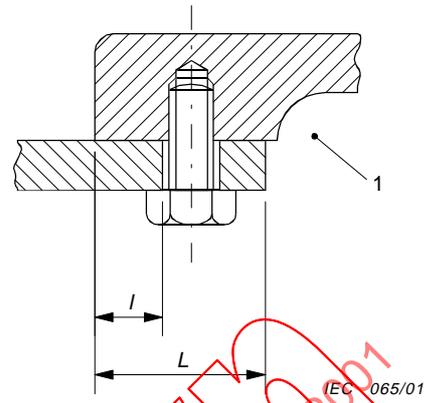


Figure 5

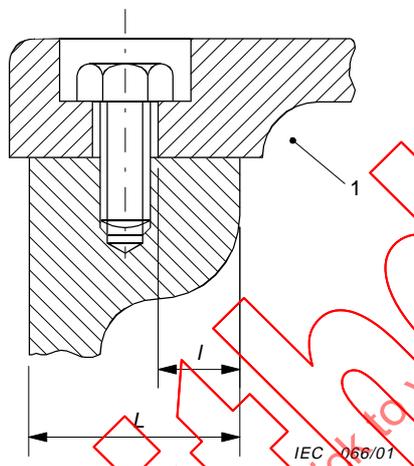


Figure 6

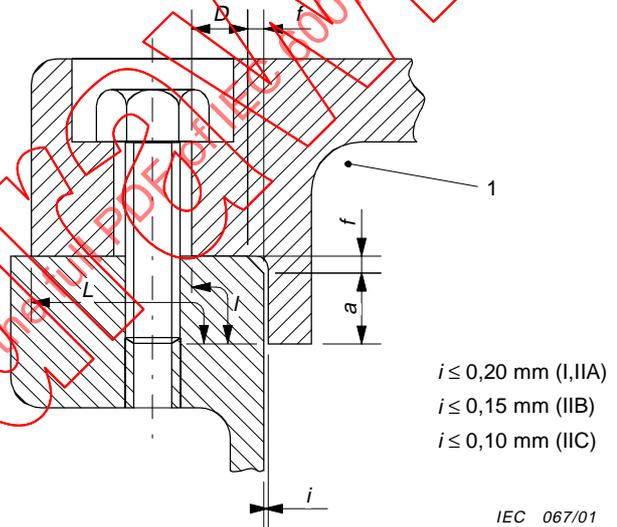


Figure 7

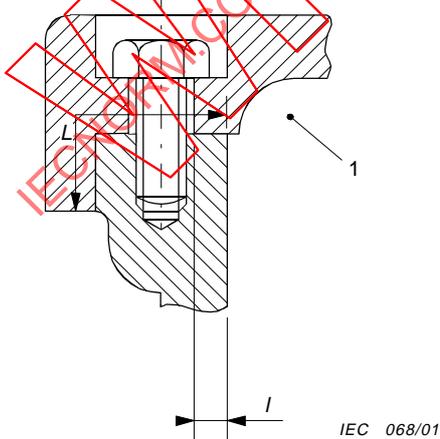


Figure 8

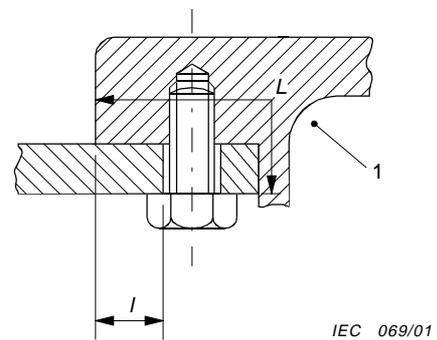


Figure 9

Key

1 Interior of enclosure

Figures 4, 5, 6 – Holes in surfaces of flanged joints

Figures 7, 8, 9 – Holes in surfaces of spigot joints

5.2.4.4 Spigot joints where, to the edges of the holes, the joint consists only of the plane part (see figures 8 and 9), in so far as plane joints are permitted (see 5.2.7)

The distance *l* is the width of the plane part between the inside of the enclosure and a hole, where the hole is outside the enclosure (see figure 8), or between a hole and the outside of the enclosure where the hole is inside the enclosure (see figure 9).

5.2.5 Conical joints

Where joints include conical surfaces, the width of the joint, and the gap normal to the joint surfaces shall comply with the relevant values in tables 1 and 2. The gap shall be uniform through the conical part. For electrical apparatus of Group IIC, the cone angle shall not exceed 5°.

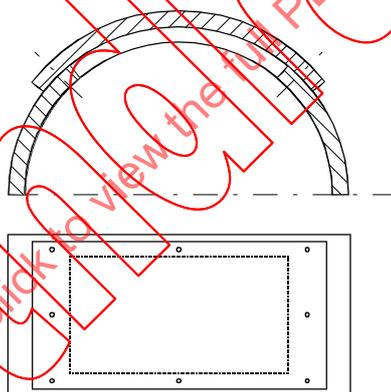
NOTE The cone angle is taken to be the angle between the vertical axis of the cone and the surface of the cone.

5.2.6 Joints with partial cylindrical surfaces (not permitted for Group IIC)

There shall be no intentional gap between the two parts (see figure 10).

The width of the joint shall comply with the requirements of table 1.

The diameters of the cylindrical surfaces of the two parts forming the flameproof joint, and their tolerances, shall ensure compliance with the relevant requirements for the gap of a cylindrical joint as given in table 1.



IEC 070/01

Figure 10 – Example of a joint with partial cylindrical surfaces

5.2.7 Additional requirements for joints of electrical apparatus of Group IIC

Flanged joints are not permitted for electrical apparatus of Group IIC intended for use in potentially explosive atmospheres containing acetylene except if the gap is $\leq 0,04$ mm for $L \geq 9,5$ mm up to 500 cm³.

5.2.8 Serrated joints

Serrated joints need not comply with the requirements of tables 1 and 2 but shall have

- a) at least five fully engaged serrations; and
- b) a pitch greater than or equal to 1,25 mm; and
- c) an included angle of 60°.

Serrated joints shall not be used for moving parts.

Serrated joints shall satisfy the test requirements of 15.2, with the test gap, i_E , between the mating serrations as specified in 15.2 based on the manufacturer's maximum constructional gap, i_C .

If the manufacturer's maximum constructional gap is different than that shown in tables 1 or 2 for a flanged joint of the same length (determined by multiplying the pitch by the number of serrations), the maximum constructional gap shall be given in the certificate and the apparatus marked "X".

See figure 10.1.

Table 1 – Minimum width of joint and maximum gap for enclosures of Groups I, IIA, and IIB

Type of joint		Minimum width of joint L mm	Maximum gap mm														
			for volume (cm ³) V ≤ 100			for volume (cm ³) 100 < V ≤ 500			for volume (cm ³) 500 < V ≤ 2 000			for volume (cm ³) V > 2 000					
			I	IIA	IIB	I	IIA	IIB	I	IIA	IIB	I	IIA	IIB			
Flanged, cylindrical or spigot joints		6	0,30	0,30	0,20	–	–	–	–	–	–	–	–	–	–	–	
		9,5	0,35	0,30	0,20	0,35	0,30	0,20	–	–	–	–	–	–	–	–	
		12,5	0,40	0,30	0,20	0,40	0,30	0,20	0,40	0,30	0,20	0,40	0,20	0,15	–	–	
		25	0,50	0,40	0,20	0,50	0,40	0,20	0,50	0,40	0,20	0,50	0,40	0,20	–	–	
Cylindrical joints for shaft glands of rotating electrical machines with		Sleeve bearings	6	0,30	0,30	0,20	–	–	–	–	–	–	–	–	–	–	
			9,5	0,35	0,30	0,20	0,35	0,30	0,20	–	–	–	–	–	–	–	
			12,5	0,40	0,35	0,25	0,40	0,30	0,20	0,40	0,30	0,20	0,40	0,20	–	–	
			25	0,50	0,40	0,30	0,50	0,40	0,25	0,50	0,40	0,25	0,50	0,40	0,20	–	–
			40	0,60	0,50	0,40	0,60	0,50	0,30	0,60	0,50	0,30	0,60	0,50	0,25	–	–
		Rolling-element bearings	6	0,45	0,45	0,30	–	–	–	–	–	–	–	–	–	–	–
			9,5	0,50	0,45	0,35	0,50	0,40	0,25	–	–	–	–	–	–	–	–
			12,5	0,60	0,50	0,40	0,60	0,45	0,30	0,60	0,45	0,30	0,60	0,30	0,20	–	–
			25	0,75	0,60	0,45	0,75	0,60	0,40	0,75	0,60	0,40	0,75	0,60	0,30	–	–
			40	0,80	0,75	0,60	0,80	0,75	0,45	0,80	0,75	0,45	0,80	0,75	0,40	–	–

NOTE Constructional values rounded according to ISO 31-0 should be taken when determining the maximum gap.

Table 2 – Minimum width of joint and maximum gap for Group IIC enclosures

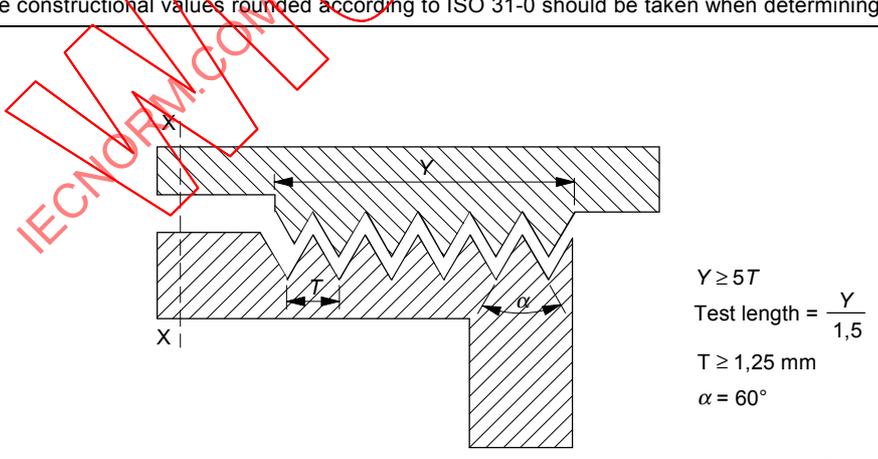
Type of joint	Minimum width of joint L mm	Maximum gap mm			
		for volume cm^3	for volume cm^3	for volume cm^3	for volume cm^3
		$V \leq 100$	$100 < V \leq 500$	$500 < V \leq 2\,000$	$V > 2\,000$
Flanged joints ¹⁾	6	0,10	–	–	–
	9,5	0,10	0,10	–	–
	15,8	0,10	0,10	0,04	–
	25	0,10	0,10	0,04	0,04
Spigot joints (figure 2)	$c \geq 6 \text{ mm}$	12,5	0,15	0,15	0,15
	$d \geq 0,5 L$	25	0,18 ²⁾	0,18 ²⁾	0,18 ²⁾
	$L = c + d$ $f \leq 1 \text{ mm}$	40	0,20 ³⁾	0,20 ³⁾	0,20 ³⁾
Cylindrical joints Spigot joints (figure 3)	6	0,10	–	–	–
	9,5	0,10	0,10	–	–
	12,5	0,15	0,15	0,15	–
	25	0,15	0,15	0,15	0,15
Cylindrical joints for shaft glands Of rotating electrical machines With rolling-element bearings	6	0,15	–	–	–
	9,5	0,15	0,15	–	–
	12,5	0,25	0,25	0,25	–
	25	0,25	0,25	0,25	0,25
	40	0,30	0,30	0,30	0,30

1) Flanged joints are not permitted for explosive mixtures of acetylene and air except if the gap is $\leq 0,04 \text{ mm}$ for $L \geq 9,5 \text{ mm}$ up to 500 cm^3 .

2) i_T of cylindrical part increased to 0,20 if $f < 0,5$.

3) i_T of cylindrical part increased to 0,25 if $f < 0,5$.

NOTE The constructional values rounded according to ISO 31-0 should be taken when determining the maximum gap.



IEC 071/01

Figure 10.1 – Example of serrated joint

5.3 Threaded joints

Threaded joints shall comply with the requirements in tables 3 or 4.

Table 3 – Cylindrical threaded joints

Pitch	≥0,7 mm ^a
Thread form and quality of fit	Medium or fine tolerance quality according to ISO 965-1 and ISO 965-3 ^b
Threads engaged	≥5
Depth of engagement	
Volume <100 cm ³	≥5
Volume >100 cm ³	≥8 mm
<p>^a Where the pitch exceeds 2 mm, special manufacturing precautions may be necessary (for example, more threads engaged) to ensure that the electrical apparatus can pass the test for non-transmission of an internal ignition which is prescribed in 15.2.</p> <p>^b Cylindrical threaded joints which do not conform with the ISO 965-3, in respect of thread form or quality of fit, are permitted if the test for non-transmission of an internal ignition that is prescribed in 15.2 is passed when the width of the threaded joint specified by the manufacturer is reduced by the amount specified in table 6.</p>	

Table 4 – Taper threaded joints

Pitch	≥0,9 mm
Threads provided on each part	≥6
Threads engaged	≥5
<p>The internal and external thread should have the same cone angle and thread form, which shall be defined.</p> <p>NOTE Difficulties may be encountered in achieving the five thread engagement for tapered threads when using standard gauging practice.</p>	

5.4 Gaskets (including O-rings)

If a gasket of compressible or elastic material is used, for example, to protect against the ingress of moisture or dust or against leakage of a liquid, it shall be applied as a supplement, that is to say neither be taken into account in the determination of the width of the flameproof joint nor interrupt it.

The gasket shall then be mounted so that

- the permissible gap and width of flanged joints or the plane part of a spigot joint are maintained;
- the minimum width of joint of a cylindrical joint or the cylindrical part of a spigot joint are maintained before and after compression.

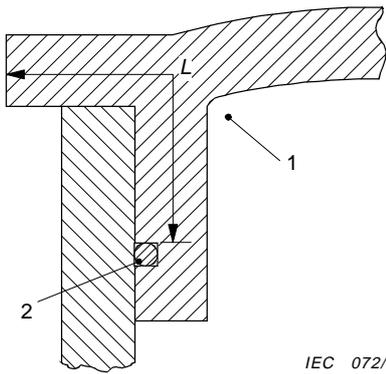


Figure 11

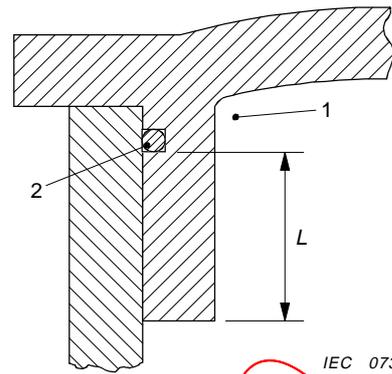


Figure 12

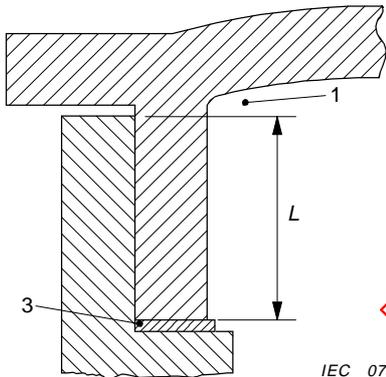


Figure 13

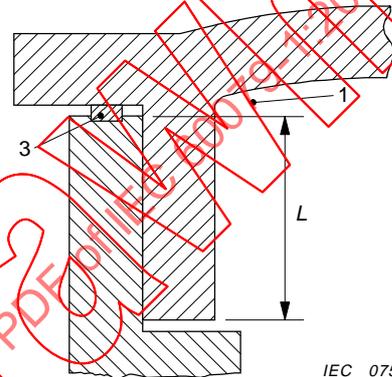


Figure 14

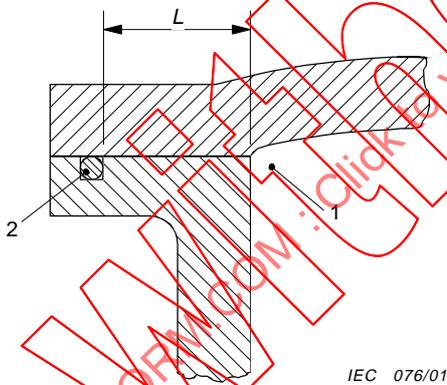


Figure 15

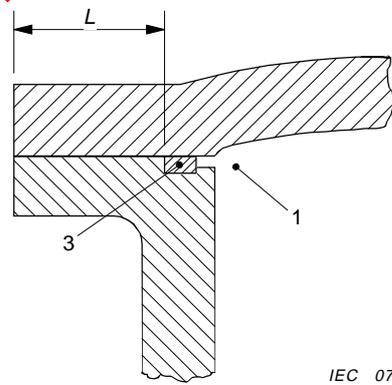
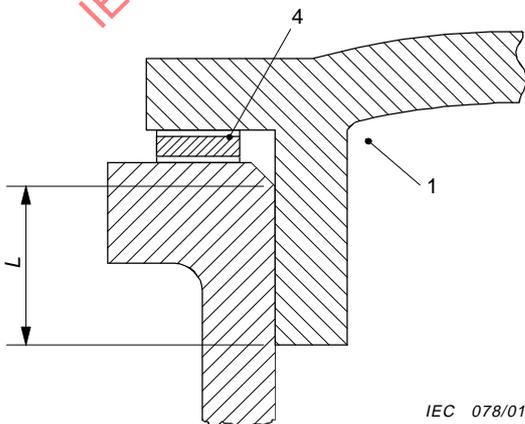


Figure 16



Key

- 1 Interior of enclosure
- 2 O-ring
- 3 Gasket
- 4 Metallic or metal sheath gasket

Figures 11 to 17 – Illustration of the requirements concerning gaskets

These requirements do not apply to cable entries (see 13.1) or to joints which contain a sealing gasket of metal or of a non-flammable compressible material with a metallic sheath. Such a sealing gasket contributes to the explosion protection, and in this case the gap between each surface of the plane part shall be measured after compression. The minimum width of the cylindrical part shall be maintained before and after compression.

5.5 Apparatus using capillaries

The capillaries shall either comply with the gap dimensions given in table 1 or table 2 for cylindrical joints using ϕ as the diameter of the inner part, or when the capillaries do not conform to the gaps given in these tables, the apparatus shall be certified if they pass the test for non-transmission of an internal ignition given in 15.2.

6 Cemented joints

6.1 General

Parts of a flameproof enclosure may be cemented either directly into the wall of the enclosure so as to form with the latter an inseparable assembly, or into a metallic frame such that the assembly can be replaced as a unit without damaging the cement.

If a joint which is cemented does not fulfil the requirements of clause 5, in the absence of the cement it shall be subjected to 23.4.7.3 and 23.4.7.4 of IEC 60079-0.

6.2 Mechanical strength

Cemented joints are only permitted to ensure the sealing of the flameproof enclosure of which they form a part. Arrangements shall be made in the construction so that the mechanical strength of the assembly does not depend upon the adhesion of the cement alone. Cemented joints shall comply with a test based on 15.3 with the relevant overpressure value given in 15.1.3.

6.3 Width of cemented joints

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	$V \leq 10 \text{ cm}^3$
≥ 6 mm if	$10 \text{ cm}^3 < V \leq 100 \text{ cm}^3$
≥ 10 mm if	$V > 100 \text{ cm}^3$

7 Operating rods

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

7.1 If the diameter of the operating rod exceeds the minimum width of the joint specified in tables 1 and 2, the width of the joint shall be at least equal to this diameter but without, however, having to exceed 25 mm.

7.2 If the diametrical clearance is liable to be enlarged as a result of wear in normal service, appropriate arrangements shall be made to facilitate a return to the original state, for example, by means of a replaceable bush. Alternatively, gap enlargement due to wear may be prevented by the use of bearings complying with clause 8.

8 Supplementary requirements for shafts and bearings

8.1 Joints of shafts

Flameproof joints of shafts of rotating electrical machines shall be arranged so as not to be subject to wear in normal service.

The flameproof joint may be

- a cylindrical joint (see figures 18 and 21), or
- a labyrinth joint (see figures 19 and 21), or
- a joint with a floating gland (see figure 20).

8.1.1 Cylindrical joints

Where a cylindrical joint contains grooves for the retention of grease, the region containing the grooves shall neither be taken into account when determining the width of a flameproof joint nor interrupt it (see figure 18).

The minimum radial clearance k (see figure 21) of shafts of rotating electrical machines shall not be less than 0,05 mm.

8.1.2 Labyrinth joints

Labyrinth joints which do not comply with the requirements of tables 1 and 2 may nevertheless be considered as complying with the requirements of this standard if the tests specified in clauses 14 through 16 are satisfied.

The minimum radial clearance k (see figure 21) of shafts of rotating electrical machines shall not be less than 0,05 mm.

8.1.3 Joints with floating glands

The determination of the maximum degree of float of the gland shall take account of the clearance in the bearing and the permissible wear of the bearing as specified by the manufacturer. The gland may move freely radially with the shaft and axially on the shaft but it shall remain concentric with it. A device shall prevent rotation of the gland (see figure 20).

Floating glands are not permitted for electrical apparatus of Group IIC.

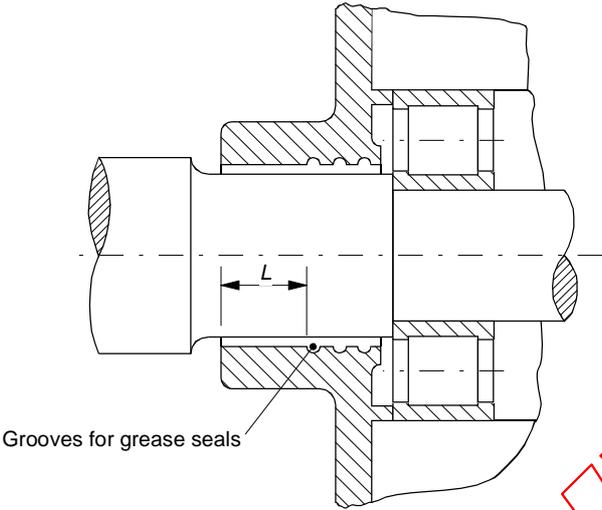


Figure 18 – Example of cylindrical joint for shaft of rotating electrical machine

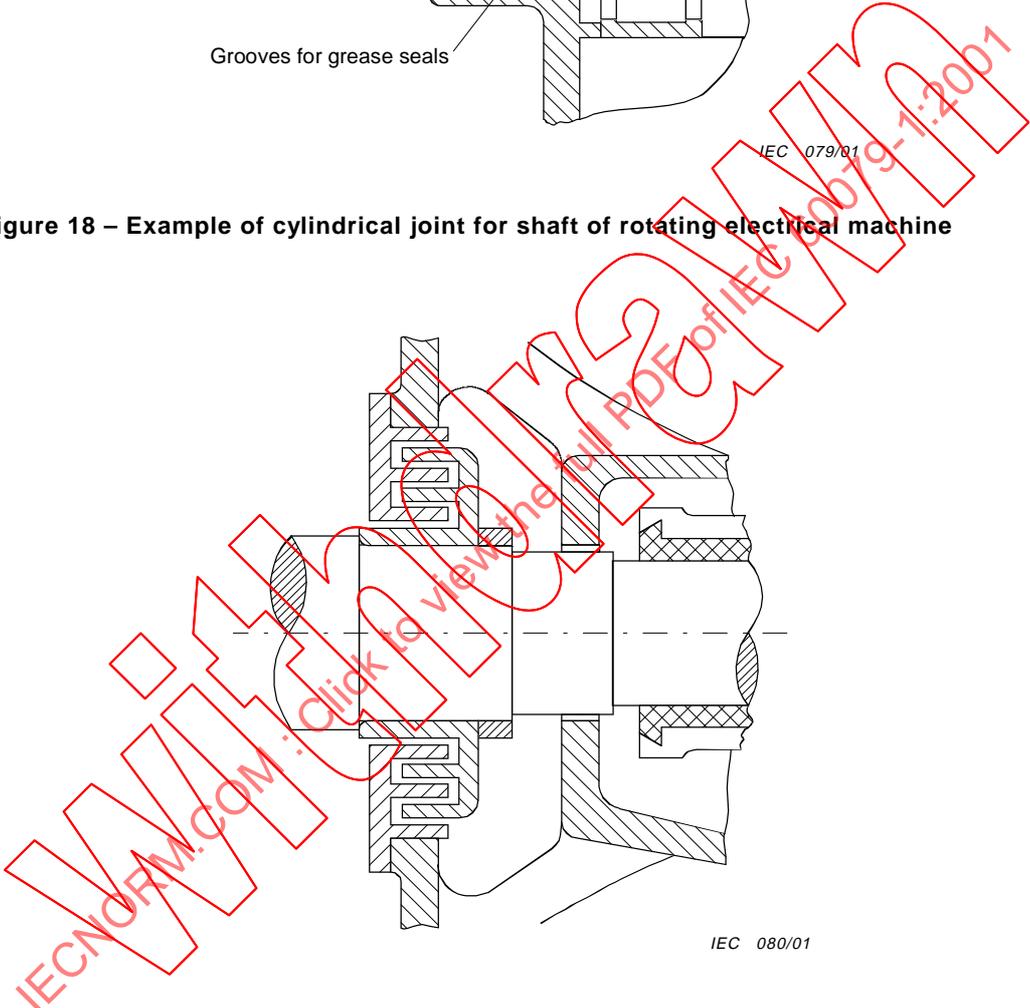
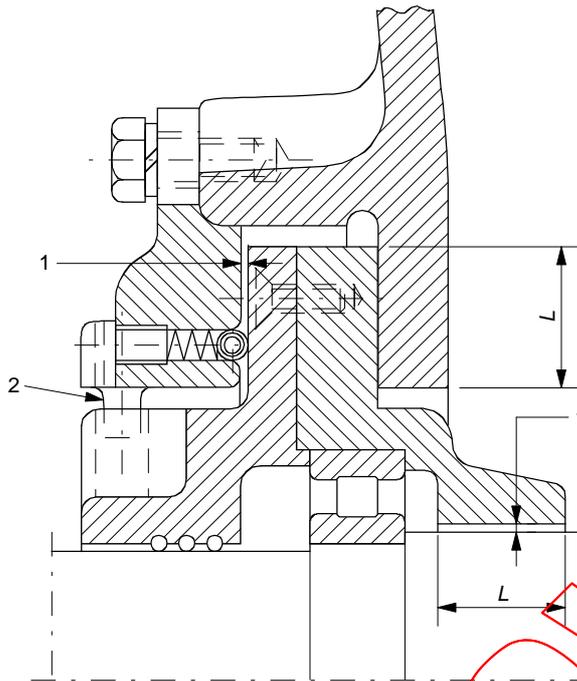


Figure 19 – Example of labyrinth joint for shaft of rotating electrical machine



Key

- 1 Gap
- 2 Stop to prevent rotation of gland

Figure 20 – Example of joint with floating gland for shaft of rotating electrical machine

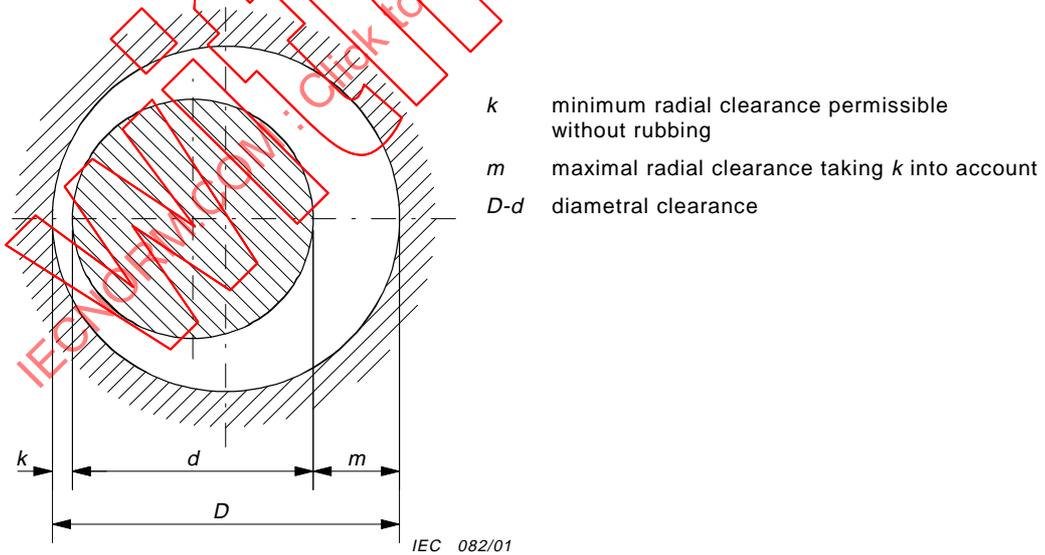


Figure 21 – Joints of shaft glands of rotating electrical machines

8.2 Bearings

8.2.1 Sleeve bearings

A flameproof joint of a shaft gland associated with a sleeve bearing shall be provided in addition to the joint of the sleeve bearing itself and shall have a width of joint at least equal to the diameter of the shaft but not exceeding 25 mm.

If a cylindrical or labyrinth flameproof joint is used in a rotating electrical machine with sleeve bearings, at least one face of the joint shall be of non-sparking metal (for example, leaded brass) whenever the air gap between stator and rotor is greater than the minimum radial clearance k (see figure 21) specified by the manufacturer. The minimum thickness of the non-sparking metal shall be greater than the air gap.

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

8.2.2 Rolling-element bearings

In shaft glands equipped with rolling-element bearings, the maximum radial clearance m (see figure 21) shall not exceed two-thirds of the maximum gap permitted for such glands in tables 1 and 2.

9 Light-transmitting parts

For light-transmitting parts of luminaires and for inspection windows of glass or plastic materials of flameproof enclosures, the requirements of IEC 60079-0 apply.

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

10 Breathing and draining devices which form part of a flameproof enclosure

Breathing and 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.

These 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.

10.1 Openings for breathing or draining

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

NOTE If for technical reasons breathing or draining devices have to be provided, they should be so constructed that they are not liable to become inoperative in service (for example, because of the accumulation of dust or paint).

10.2 Composition limits

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 or draining devices for use in potentially explosive atmosphere containing acetylene shall comprise not more than 60 % of copper by mass to limit acetylide formation.

10.3 Dimensions

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

10.4 Elements with measurable paths

Interstices and measurable lengths of path need not comply with the values given in tables 1 and 2 provided that the elements pass the tests of clauses 14 through 16.

Additional requirements for crimped ribbon elements are given in annex A.

10.5 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 annex B.

The elements are classified according to their density as well as their pore size in accordance with the standard methods for the particular material and the particular manufacturing methods (see annex B).

NOTE For functional reasons, it may also be necessary to state the fluid permeability and the open porosity specified in accordance with the standard methods for the particular material and the particular manufacturing methods (see annex B).

10.6 Removable devices

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

10.7 Mounting arrangements of the elements

The breathing and draining elements shall be sintered, 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, for example press-fitted in accordance with 5.2.1, so as to form a flameproof joint. In this case, the appropriate requirements of clause 5 are to be applied, with the exception that the surface roughness of the element need not comply with 5.2.2, if the element arrangement passes the type test in clauses 14 through 16.

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 ring shall be possible only from the inside, or
- from outside the enclosure, in which case the fasteners shall comply with clause 11.

10.8 Mechanical strength

The device and its guard, if any, shall, when mounted normally, pass the test for resistance to impact in 23.4.7.7 of IEC 60079-0.

10.9 Breathing devices and draining devices when used as Ex components

The certification of breathing and draining devices as component devices is limited to application on flameproof enclosure volumes of 3L or less.

NOTE A breathing and draining device may be used as an integral part of flameproof enclosure volumes larger than 3L provided it is tested with the specific enclosure in accordance with 15.4.

In addition to clause 10 through 10.6 inclusive, the following requirements shall apply to breathing and draining devices which are certified as Ex components.

10.9.1 Mounting arrangements of the elements and components

The breathing and draining elements shall be sintered or cemented in accordance with clause 6, or fixed by other methods into a suitable mounting part to form the mounting component.

The mounting component is secured by clamping or by fasteners or screwed into the enclosure as a replaceable unit complying with the relevant requirements of clauses 5 and 6 and, where appropriate, clause 11.

10.9.2 Type tests for breathing and draining devices used as Ex components

Attachment of the sample device under test shall be made on the end of the test rig enclosure in the same manner as it would normally be mounted on a flameproof enclosure. The test shall be performed on the sample after the impact test of 10.8 and in accordance with 10.9.2.1 to 10.9.2.3.

NOTE The impact test may be performed on the sample, separate from the test enclosure when it is mounted on a plate that forms the end part of the test rig enclosure.

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

10.9.2.1 Test of the ability of the breathing and draining device to withstand pressure

10.9.2.1.1 Test procedure

The reference test pressures in each gas group are:

- Group I 1 200 kPa
- Group IIA 1 350 kPa
- Group IIB 2 500 kPa
- Group IIC 4 000 kPa

For the purpose of the test, a thin flexible membrane is fitted over the inner surfaces of the breathing and draining devices. The reference pressure shall be one of the relevant pressures given above for the gas group for which the component is intended.

One of the following overpressure tests shall be applied:

- 1,5 times the reference pressure for a period of 1 min. Then each component shall be submitted to a routine test, or
- 4 times the reference pressure for a period of 1 min. If this test is successful, the manufacturer is not required to apply the routine test to all future components of the tested type.

10.9.2.1.2 Acceptance criteria

After the overpressure tests, the device shall show no permanent deformation or damage affecting the type of protection.

It shall be used as the test sample for all subsequent type tests.

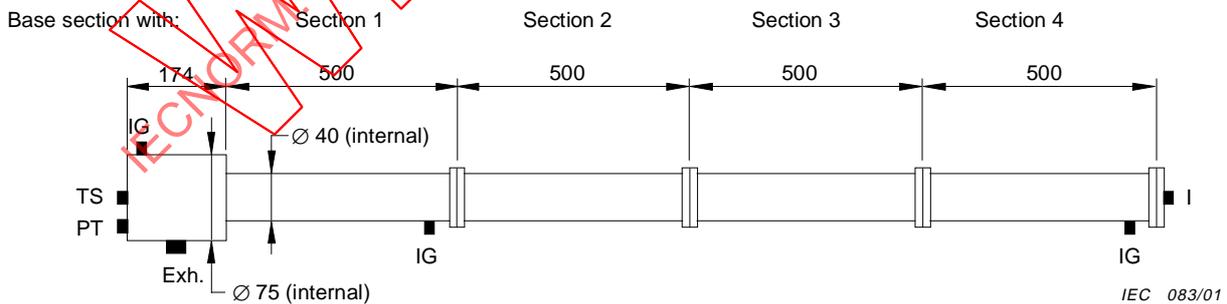
10.9.2.2 Thermal tests

Breathing and draining devices intended for multiple use in any single flameproof enclosure shall be tested additionally with the enclosure.

10.9.2.2.1 Test procedure

The test rig assembly with all four sections, as shown in figure 21.1, shall be used, and the test procedure shall be carried out as follows:

- the position of the ignition source shall be at the enclosure inlet and 50 mm from the inside of the end-plate housing the device and the results observed;
- the test mixtures shall be as for 15.4.2.1, as appropriate;
- the temperature of the external surface of the device shall be monitored during tests;
- any device shall be operated as specified by the manufacturer's documentation. After each of five tests, the explosive mixture shall be maintained external to the device for a sufficient time to allow any continuous burning on the face of the device to become evident, for at least 10 min, so as to increase the temperature of the external surface of the device or to make temperature transfer to the outer face possible;
- the tests shall be carried out five times for each gas mixture for the gas groups in which the device is intended for use.



- TS = Test sample position
- I = Inlet
- Exh. = Exhaust outlet
- IG = Ignition source
- PT = Pressure transducer

Figure 21.1 – Component test rig for breathing and draining devices

10.9.2.2.2 Acceptance criteria

During the thermal tests, no flame transmission shall occur, and no continuous burning shall be observed. The device shall show no evidence of thermal or mechanical damage or deformation which could affect its flame-arresting properties.

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.

NOTE Breathing and draining devices which fail any of the tests of 10.9 are excluded from certification as a component device. However, they may be used as an integral part of a flameproof enclosure provided they are tested with the specific enclosure in accordance with 15.4.

10.9.2.3 Test for non-transmission of an internal ignition

This test shall be carried out on a standard test rig, as illustrated in figure 21.1, and made in accordance with 15.4.3 with the following additions and modifications.

10.9.2.3.1 Test procedure

The position of the ignition source shall be as shown in figure 21.1:

- at the inlet end, and
- at 50 mm from the inside of the end-plate housing the device.

For the purposes of the test, the test rig shall be assembled for each gas group, in accordance with figure 21.1, and have the following number of sections:

- Group I and Group IIA: one section of test rig assembly;
- Group IIB and Group IIC: four sections of test rig assembly.

The gas mixture within the test rig enclosure shall be ignited and the tests shall be made five times at each ignition point.

For breathing and draining devices of Groups I, IIA and IIB having either measurable paths or non-measurable paths, the non-transmission test of 15.2.1 shall be applied.

For breathing and draining devices of Group IIC with measurable paths, the non-transmission test of 15.2.2 and either 15.4.3.2.1 or 15.4.3.2.2 are to be applied.

For breathing or draining devices of Group IIC with non-measurable paths, 15.4.3.2.1 or 15.4.3.2.2 shall be applied.

10.9.2.3.2 Acceptance criteria

During the test, no ignition shall be transmitted to the surrounding test chamber.

10.9.3 Marking

The marking of breathing and draining devices used as Ex components shall be as follows:

- all breathing and draining devices shall be certified in the name of the original component manufacturer who shall ensure that all future component devices are made in accordance with the certified type;
- each device shall be marked in accordance with IEC 60079-0. In addition, each device or package of devices shall be accompanied by a component certificate which shall include the limiting reference pressure of the devices.

10.9.4 Component certificate

Component certification documents shall record all details necessary to properly select a breathing or draining device for attachment to a type tested flameproof enclosure. The component certificate, issued by the certifying authority, shall show

- a) the manufacturer's name and identifying drawings and specifications;
- b) the limiting reference pressure;

NOTE The selection of the device used as a component is made such that the limiting reference pressure of the device shall be not less than the reference pressure of the flameproof enclosure (tested with breathing and draining device entries plugged) to which the device is to be attached.

- c) the maximum recorded surface temperature obtained during the type test corrected to 40 °C, or to the higher marked ambient;
- d) the Group, i.e. I, IIA, IIB, or IIC.

In addition, the component certificate shall require that each component or package of components be accompanied by a copy of the certificate, together with a manufacturer's declaration stating

- compliance with the certified conditions;
- confirmation of the material, maximum bubble pore size and minimum density, where applicable;
- special mounting instructions, if any.

11 Fasteners, associated holes and closing devices

11.1 Fasteners accessible from the outside and necessary for the assembly of the parts of a flameproof enclosure shall

- for Group I, be special fasteners complying with the requirements of IEC 60079-0. When heads of fasteners are not protected, for example by counter-bored holes, the electrical apparatus shall be marked "X";
- for Group II, be in conformity with 9.2 of IEC 60079-0 in respect of threads and heads.

11.2 Fasteners of plastic material or light alloys are not permitted.

11.3 The lower yield stress of screws and nuts shall be at least 240 N/mm² according to ISO 6892.

In carrying out the type tests specified in clause 15, the testing station shall require the replacement of all or some of the screws specified by the manufacturer, if these are of a higher field stress than 240 N/mm², by screws of the lowest yield stress available, but with a minimum of 240 N/mm², unless a calculation based on a pressure of 1,5 times the reference pressure shows that a higher yield stress is necessary.

If a yield stress higher than 240 N/mm² is necessary, the required yield stress shall be

- either marked on the apparatus, or
- specified in the relevant certificate, in which case the apparatus shall be marked with an "X".

The type test is then carried out with the screws and nuts specified by the manufacturer.

11.4 Studs shall be securely fixed i.e. they shall be welded or riveted or permanently attached to the enclosure by another equally effective method.

If a yield stress higher than 240 N/mm² is necessary, the required yield stress shall be

- either marked on the apparatus, or
- specified in the relevant certificate, in which case the apparatus shall be marked "X".

The type test is then carried out with the studs specified by the manufacturer.

11.5 Fasteners shall not pass through the walls of a flameproof enclosure, unless they form a flameproof joint with the wall and are non-detachable from the enclosure, for example by welding, riveting or an equally effective method.

11.6 In the case of holes for screws or studs which do not pass through the walls of flameproof enclosures, the remaining thickness of the wall of the flameproof enclosure shall be at least one-third of the nominal diameter of the screw or stud with a minimum of 3 mm.

11.7 When screws are fully tightened into blind holes in enclosure walls, with no washer fitted, at least one full thread shall remain free at the base of the hole.

11.8 If, for ease of manufacture, a wall of a flameproof enclosure has to be drilled through, the resulting hole shall subsequently be closed by a device so that the flameproof properties of the enclosure are maintained. This device shall be securely fixed in accordance with the requirements of 11.4 for studs.

11.9 If apertures provided in a flameproof enclosure (for example, for cable or conduit entry) are not used, they shall be closed so that the flameproof properties of the enclosure are maintained (see figure 22 for examples).

The closing device may be made so that it can be fitted or removed from either the outside or the inside of the wall of the flameproof enclosure.

The mechanically or frictionally locked blanking element shall comply with one or more of the requirements of 11.9.1 to 11.9.3.

11.9.1 If the closing device is removable from the outside, this shall be possible only after disengagement of a retaining device inside the enclosure (see figure 22a).

11.9.2 It may be so designed that it can be fitted or removed only by the use of a tool complying with the requirements of 9.2 of IEC 60079-0 (see figure 22b).

11.9.3 It may be of a special construction in which insertion is done by a method other than that used for removal. Removal shall only be by one of the methods specified in 11.9.1 or 11.9.2 or by a special technique (see figure 22c).

11.10 Separate fastening arrangements, requiring the use of a tool, of the type required in 9.2 of IEC 60079-0 or some equally effective methods shall be provided to secure and release threaded doors or covers.

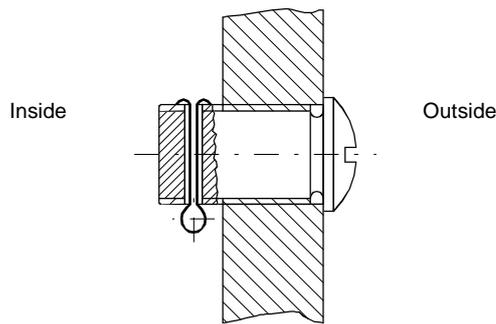


Figure 22a

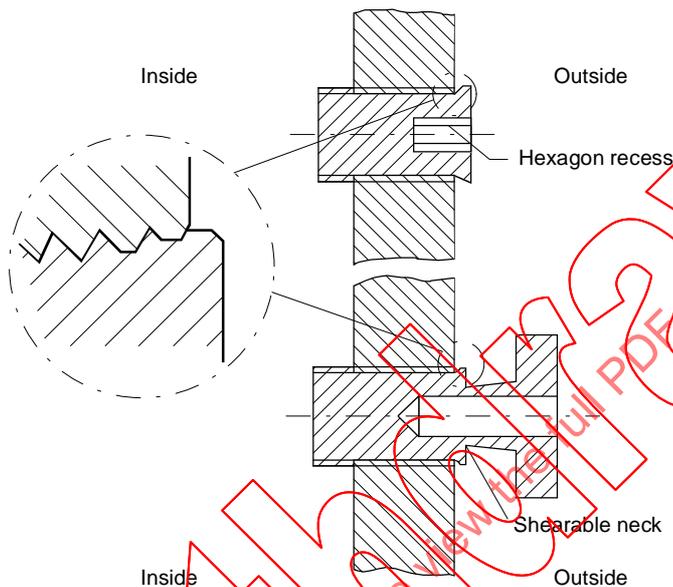


Figure 22b

Figure 22c

IEC 084/01

Figure 22 – Examples of closing devices for unused apertures

12 Materials and mechanical strength of enclosures; materials inside the enclosures

12.1 Flameproof enclosures shall withstand the relevant tests prescribed in clauses 14 through 16.

12.2 When several flameproof enclosures are assembled together, the requirements of this standard apply to each of them separately, and in particular to the partitions separating them and to all the bushings and operating rods which pass through the partitions.

12.3 When an enclosure contains several intercommunicating compartments or when it is subdivided because of the disposition of the internal parts, pressures and rates of rise of pressure greater than normal may be produced.

Such phenomena shall be precluded as far as possible by the construction. If it is impossible to avoid these phenomena, the resulting higher stresses shall be taken into account in the construction of the enclosure.

12.4 When cast iron is used, the material shall be not less than the quality 150 (ISO 185).

12.5 Liquids shall not be used in flameproof enclosures when there is a risk of producing an explosive mixture, more hazardous than that for which the enclosure was designed, by the decomposition of these liquids. They may, however, be used if the enclosure passes the tests prescribed in clauses 14 through 16 for the type of explosive mixture produced; however, the surrounding explosive atmosphere shall be appropriate to the group for which the electrical apparatus is constructed.

12.6 In flameproof enclosures of Group I, insulating materials subjected to electrical stresses capable of causing arcs in air and which result from rated currents of more than 16 A (in switching apparatus such as circuit-breakers, contactors, isolators) shall have a comparative tracking index equal to or greater than CTI 400 M, according to IEC 60112.

However, if the above-mentioned insulating materials do not pass this test, they may be used if their volume is limited to 1 % of the total volume of the empty enclosure or if a suitable detection device enables the power supply to the enclosure to be disconnected, on the supply side, before possible decomposition of the insulating material leads to dangerous conditions. The presence and effectiveness of such a device shall be verified by the testing station.

13 Entries for flameproof enclosures

The flameproof properties of the enclosure are not altered if all entries meet the relevant requirements given in this clause.

The following different means can be used to provide the connection of electrical apparatus within a flameproof enclosure to external circuits or to other electrical apparatus, nevertheless, the manufacturer shall state, in the documents defining the electrical apparatus, those means which are explicitly intended to be used for this purpose, the places where they can be mounted and the maximum permitted number of these means.

13.1 Cable entries

Cable entries, whether integral or separate, shall meet the requirements of this standard, the relevant requirements of annex C and create, on the enclosure, the joint widths and gaps prescribed in clause 5.

Where cable entries are integral with the enclosure or specific to the enclosure they will be tested as part of the enclosure concerned.

Where cable entries are separate

- threaded Ex cable entries can be certified as apparatus. Such cable entries do not have to be submitted to the tests of 15.1 and the routine test of clause 16. Threaded cable entries and their associated holes with threads not complying with ISO standards shall be marked in such a manner that any confusion can be precluded;
- other cable entries can only be certified as an Ex component.

13.2 Conduit entries

13.2.1 Conduit entries are permitted only for electrical apparatus of Group II.

13.2.2 Conduit entries shall create on the enclosure the joint widths and gaps prescribed in clause 5.

13.2.3 In addition, a sealing device such as a stopping box with setting compound shall be provided, either in the flameproof enclosure or immediately at the entrance thereto. A sealing device is considered as fitted immediately at the entrance of the flameproof enclosure when the device is fixed to the enclosure either directly or through an accessory necessary for coupling (such as a nipple or a three-piece union); it shall satisfy the type test for sealing prescribed in 15.3. The setting compound shall be specified in the certificate either of the stopping box or of the complete electrical apparatus having the flameproof enclosure. The part of the stopping box between the setting compound and the flameproof enclosure shall be treated as a flameproof enclosure, i.e. the joints shall comply with clause 5 and the assembly shall be submitted to the tests for non-transmission of 15.2.

NOTE The sealing device may be applied by the installer or user of the electrical apparatus according to instructions provided by the manufacturer.

13.3 Plugs and sockets and cable couplers

13.3.1 Plugs and sockets shall be constructed and mounted so that they do not alter the flameproof properties of the enclosure on which they are mounted, even when the two parts of the plugs and sockets are separated.

13.3.2 The widths and the gaps of the flameproof joints (see clause 5) of the flameproof enclosures of plugs and sockets and cable couplers 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 parts of circuits complying with IEC 60079-11.

13.3.3 For plugs and sockets and cable couplers, the flameproof properties of the enclosure shall be maintained in the event of an internal explosion both when the plugs and sockets or cable couplers are connected together and at the moment of separation of the contacts other than those for earthing or bonding or those which are parts of circuits complying with IEC 60079-11.

13.3.4 The requirements of 13.3.2 and 13.3.3 do not apply to plugs and sockets nor to cable couplers fixed together by means of special fasteners conforming to 11.1 and which bear a label with the warning

"DO NOT SEPARATE WHEN ENERGIZED".

13.4 Bushings

13.4.1 Bushings may contain one or more conductors. When they are correctly assembled and mounted in the walls of the enclosure, all joint widths, gaps or cemented joints shall conform with the relevant requirements of clauses 5 and 6.

When the bushing is formed by moulding insulation on metallic parts the requirements of 5.2, 5.3 and 5.4 do not apply, but clause 6 is applicable. The insulation material itself can contribute to the mechanical strength of the enclosure.

When the bushing includes parts assembled with adhesive, this is considered as a cement if it complies with the requirements of clause 6. Should this not be the case, the requirements of 5.2.1, 5.3 and 5.4 are applicable.

13.4.2 The parts of bushings outside the flameproof enclosure shall be protected in accordance with one of the types of protection listed in IEC 60079-0.

13.4.3 Bushings specific to a flameproof enclosure shall satisfy the type tests and routine tests for that enclosure.

13.4.4 Bushings not specific to one flameproof enclosure shall be submitted to a type test for resistance to pressure carried out by means of a static pressure test as specified in 15.1.3.1 at the following values:

- 20 bar for electrical apparatus of Group I;
- 30 bar for electrical apparatus of Group II.

These bushings shall be subject to a routine pressure test as specified in 16.1, except where the assembly procedure used is described in the manufacturer's documentation and is such as to ensure consistency in the manufactured products.

14 Verification and tests

The requirements of IEC 60079-0 concerning verifications and tests are, for the type of protection flameproof enclosure "d", supplemented by the following requirements.

The determination of the maximum surface temperature specified in 23.4.6.1 of IEC 60079-0 shall be made under the conditions defined in table 5 of this standard.

Table 5 – Conditions for the determination of maximum surface temperature

Type of electrical apparatus	Test voltage	Overload or fault conditions
Luminaires (without ballast)	$U_n + 10\%$	None
Ballast	$U_n + 10\%$	$U_n + 10\%$ Rectifier effect simulated by diode ^a
Motors	$U_n \pm 5\%$	None
Resistors	$U_n + 10\%$	None
Electromagnets	$U_n + 10\%$	U_n and worst-case air-gap
Other apparatus	$U_n \pm 10\%$	^b
NOTE U_n is the rated voltage of the apparatus.		
^a The rectifier effect is only to be simulated in the case of ballasts for tubular fluorescent lamps.		
^b To be agreed between manufacturer and testing station, depending on the type of apparatus.		

15 Type tests

The type tests shall be carried out in the following sequence on one of the samples which has been subjected to the mechanical tests in accordance with 23.4.3 of IEC 60079-0.

- a) Determination of the explosion pressure (reference pressure) in accordance with 15.1.2.
- b) Overpressure test in accordance with 15.1.3.
- c) Test for non-transmission of an internal ignition in accordance with 15.2.

Testing stations may deviate from this test sequence in that the static or dynamic overpressure test may be carried out either after the test for non-transmission of an internal ignition or on another sample which has also been subjected to those other tests affecting mechanical strength already applied to the first sample; in no case, after the overpressure test, shall the joints of the enclosure have suffered a permanent deformation nor shall the enclosure have suffered any damage affecting the type of protection.

The enclosure shall, in general, be tested with all the enclosed apparatus in place. However, this may, with the agreement of the testing station, be replaced by equivalent models.

If an enclosure is designed to take different types of apparatus and components, declared with the detailed mounting arrangements by the manufacturer, the enclosure may be tested empty provided that this is the most severe condition for explosion pressure development, and compliance with the other safety requirements of IEC 60079-0 can be confirmed.

If the enclosure is designed so that it can be used in the absence of part of the enclosed apparatus, the tests shall be made under the conditions considered by the testing station to be the most severe. In both cases, the testing station shall then indicate in the certificate, on the basis of the proposals made by the manufacturer, the kinds of enclosed apparatus permitted and their mounting arrangements.

Joints of removable parts of flameproof enclosures shall be tested in the worst-case assembly conditions.

15.1 Tests of ability of the enclosure to withstand pressure

15.1.1 General

The object of these tests is to verify that the enclosure can withstand the pressure of an internal explosion.

The enclosure shall be subjected to tests in accordance with 15.1.2 and 15.1.3.

The tests are considered satisfactory if the enclosure suffers no permanent deformation or damage, affecting the type of protection. In addition, the joints shall in no place have been permanently enlarged.

15.1.2 Determination of explosion pressure (reference pressure)

The reference pressure is the highest value of the maximum smoothed pressure, relative to atmospheric pressure, observed during these tests. For smoothing, a frequency limit of 5 kHz \pm 10 % shall be adopted.

15.1.2.1 Each test consists of igniting an explosive mixture inside the enclosure and of measuring the pressure developed by the explosion.

The mixture shall be ignited by one or more sparking plugs or another low-energy source. However, when the enclosure contains a device which produces sparks capable of igniting the explosive mixture, this device may be used to produce the explosion. (It is nevertheless not necessary to produce the maximum power for which the device is designed.)

The pressure developed during the explosion shall be determined and recorded during each test. The locations of the sparking plug(s) as well as those of the pressure gauge(s) are left to the discretion of the testing station, to find the combination which produces the highest pressure. When detachable gaskets are provided by the manufacturer, these shall be fitted to the enclosure under test.

The number of tests to be made and the explosive mixture to be used, in volumetric ratio with air and at atmospheric pressure, are as follows:

- electrical apparatus of Group I: three tests with $(9,8 \pm 0,5)$ % methane;
- electrical apparatus of Group IIA: three tests with $(4,6 \pm 0,3)$ % propane;
- electrical apparatus of Group IIB: three tests with $(8 \pm 0,5)$ % ethylene;
- electrical apparatus of Group IIC: three tests with (14 ± 1) % acetylene and three tests with (31 ± 1) % hydrogen.

15.1.2.2 Rotating electrical machines shall be tested at rest and, when the testing station considers it necessary, when running. When they are tested running, they may be driven either by their own source of power or by an auxiliary motor. The speed shall be between 90 % and 100 % of the rated speed of the machine.

The pressures shall be determined at the ignition end, at the opposite end and at all points where higher pressures are likely to occur.

15.1.2.3 In cases where pressure-piling may occur during the test of flameproof enclosures, the tests shall be made with each gas at least five times. For Group IIB they shall afterwards be repeated at least five times with a mixture of (24 ± 1) % hydrogen/methane (85/15).

NOTE 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 $\geq 1,5$, or
- the pressure rise time is less than 5 ms.

15.1.2.4 Electrical apparatus intended to be used in a single specified gas may be tested with the mixture of that gas with air at atmospheric pressure that gives the highest explosion pressure. Such electrical apparatus shall then be certified not for the corresponding group but only for the gas considered. The restriction of use shall be indicated accordingly, as specified in 27.2e) of IEC 60079-0.

Where exclusion of a specific gas or gases is required, the apparatus shall be marked "X".

Double marking can be applied for a specific gas and for the next lower group than the group of this gas (for example, IIB + H₂), if the enclosure has been submitted not only to the tests for the specific gas, but also to those necessary for the lower group.

15.1.3 Overpressure test

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

15.1.3.1 Overpressure test: first method (static)

The relative pressure applied shall be

- 1,5 times the reference pressure, with a minimum of 3,5 bar, or
- 4 times the reference pressure for enclosures not subject to routine overpressure testing, or
- the following pressures, when reference pressure determination has been impracticable.

Volume cm ³	Group	Pressure bar
≤10	I, IIA, IIB, IIC	10
>10	I	10
>10	IIA, IIB	15
>10	IIC	20

The period of application of the pressure shall be at least 10 s but need not exceed 60 s.

The test is made once.

The overpressure test shall be considered satisfactory if the test result is in compliance with 15.1.1 and if there is no leakage through the walls of the enclosure.

15.1.3.2 Overpressure test: second method (dynamic)

The dynamic tests shall be so carried out that the maximum pressure to which the enclosure is subjected is 1,5 times the reference pressure, but with a minimum of 3,5 bar.

When the test is carried out with mixtures specified in 15.1.2.1, these may be precompressed to produce an explosion pressure of 1,5 times the reference pressure.

The test shall be made once only except for electrical apparatus of Group IIC for which each test shall be made three times with each gas.

The overpressure test shall be considered satisfactory if the test result is in compliance with 15.1.1.

15.2 Test for non-transmission of an internal ignition

Gaskets (see 5.4) are to be removed. The enclosure is placed in a test chamber. The same explosive mixture is introduced into the enclosure and the test chamber, at atmospheric pressure.

The length of threaded joints shall be reduced according to table 6.

Flanged gaps of spigot joints, where the width of the joint L consists only of a cylindrical part (see figure 3) are to be enlarged to values of 1 mm for Groups I and IIA, 0,5 mm for Group IIB and 0,3 mm for Group IIC.

Table 6 – Reduction in length of a threaded joint for non-transmission test

Type of threaded joint	Reduction in length by			
	Groups I, IIA and IIB (15.2.1)		Group IIC (15.2.2)	
	15.2.1.1	15.2.1.2	15.2.2.1	15.2.2.2
Cylindrical, complying with ISO 965 fit medium or better	No reduction	1/3	1/3	No reduction
Cylindrical, with larger tolerances than permitted above	1/3	1/2	1/2	1/3
Taper	No reduction	1/3	1/3	No reduction

NOTE For tapered threads, the joint should be tested with the minimum handtight engagement permitted by the thread standard at the extremes of tolerances.

Example of reduction of tapered threads:
After marking the position of handtight engagement on the thread, the devices are removed and the length of engagement is reduced by cutting the screw or drilling out the hole. The parts are then reassembled to the marked position.

15.2.1 Electrical apparatus of Groups I, IIA and IIB

15.2.1.1 The gaps i_E of the enclosure shall be at least equal to 90 % of the maximum constructional gap i_C as specified in the manufacturer's drawings ($0,9 i_C \leq i_E \leq i_C$).

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

- electrical apparatus of Group I: (12,5 ± 0,5) % methane-hydrogen [(58 ± 1) % methane and (42 ± 1) % hydrogen] (MESG = 0,8 mm)
- electrical apparatus of Group IIA: (55 ± 0,5) % hydrogen (MESG = 0,65 mm)
- electrical apparatus of Group IIB: (37 ± 0,5) % hydrogen (MESG = 0,35 mm)

NOTE The explosive mixtures chosen for this test ensure that the joints prevent the transmission of an internal ignition, with a known margin of safety. This margin of safety, K , is the ratio of the maximum experimental safe gap of the representative gas of the Group concerned to the maximum experimental safe gap of the chosen test gas:

- electrical apparatus of Group I: $K = \frac{1,14}{0,8} = 1,42$ (methane),
- electrical apparatus of Group IIA: $K = \frac{0,92}{0,65} = 1,42$ (propane),
- electrical apparatus of Group IIB: $K = \frac{0,65}{0,35} = 1,85$ (ethylene).

Alternatively, by agreement between the testing station and the manufacturer, if the gaps of a test specimen do not fulfill the above condition, one of the following methods may be used for the type test for non-transmission of an internal ignition:

- a gas/air mixture with a smaller MESG value:

	i_E/i_C	Mixture
Group I	$\geq 0,75$	55 % H ₂ ± 0,5
	$\geq 0,6$	50 % H ₂ ± 0,5
Group IIA	$\geq 0,75$	50 % H ₂ ± 0,5
	$\geq 0,6$	45 % H ₂ ± 0,5
Group IIB	$\geq 0,75$	28 % H ₂ ± 1
	$\geq 0,6$	28 % H ₂ ± 1 at 1,4 bar

- Precompression of the normal test mixtures according to the following formula

$$P_k = \frac{i_C}{i_E} \times 0,9$$

where P_k is the precompression factor.

15.2.1.2 If enclosures of Groups IIA and IIB could be destroyed or damaged by the test in 15.2.1.1, 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 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) % propane
- electrical apparatus of Group IIB: (6,5 ± 0,5) % ethylene

15.2.1.3 The test in 15.2.1.1 or 15.2.1.2 shall be made five times. The test result is considered satisfactory if the ignition is not transmitted to the test chamber.

15.2.2 Electrical apparatus of Group IIC

The following methods can be used for this test.

15.2.2.1 First method

All gaps of joints other than threaded joints shall be increased to the value

$$i_E = 1,5 \times i_C$$

with a minimum of 0,1 mm for flanged joints

where

i_E is the test gap;

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

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

- (27,5 ± 1,5) % hydrogen, and
- (7,5 ± 1) % acetylene.

Five tests shall be made with each mixture. If the apparatus is intended for use solely with hydrogen or solely with acetylene, the tests shall be made only with the corresponding gas mixture.

15.2.2.2 Second method

The enclosure shall be tested with a test gap according to the following formula

$$0,9 i_C \leq i_E \leq i_C$$

The enclosure and the test chamber are filled with one of the gas mixtures specified for the first method at a pressure equal to 1,5 times atmospheric pressure.

The test shall be carried out five times with each explosive mixture.

Alternatively, if the gaps of a test specimen do not fulfil the above condition, by agreement between testing station and manufacturer, the following method may be used.

Precompression of the normal test mixtures according to the following formula:

$$P_k = \frac{i_C}{i_E} \times 1,35$$

where P_k is the precompression factor.

15.2.2.3 Electrical apparatus which are single constructions shall be tested five times with unaltered gaps and with each of the explosive mixtures specified in 15.2.2.1 at atmospheric pressure.

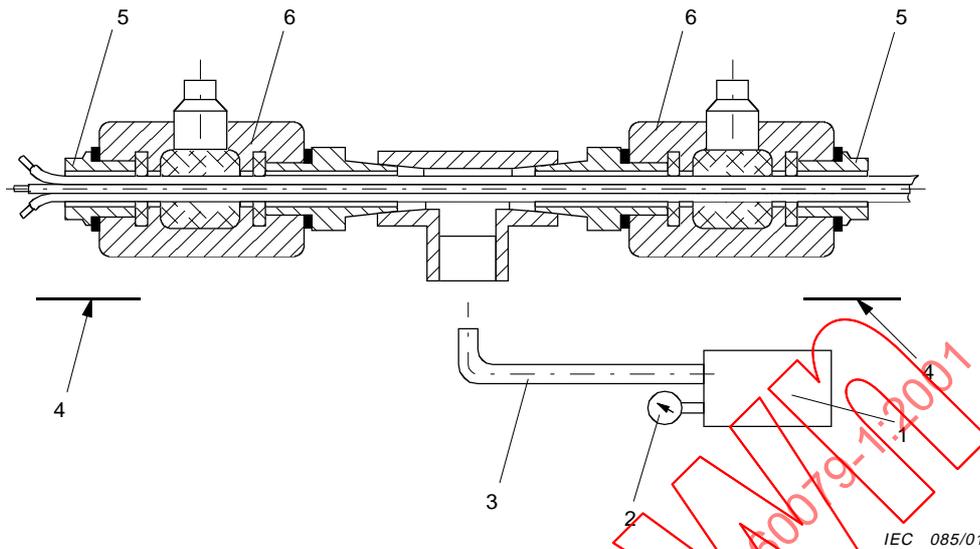
15.3 Test for sealing of stopping boxes with setting compound

A hydraulic testing device which avoids the application of pressure to the ends of the conductors is to be used: figure 23 shows an example of a device fulfilling this condition and allowing a simultaneous test on two stopping boxes.

The combination of conductors or cables to be placed in the conduit is chosen by the testing station so as to obtain the most unfavourable conditions.

Filling of the stopping box submitted to the sealing test is carried out in accordance with the instructions of the manufacturer of the stopping box.

A piece of clean white blotting paper is placed under the stopping boxes being tested so as to detect any leakage of liquid. The liquid to be used is coloured water. The hydraulic circuit is to be purged.



Key

- | | |
|------------------|--|
| 1 Hydraulic pump | 4 Blotting paper |
| 2 Pressure gauge | 5 Packing gland to be removed for the test |
| 3 Hose | 6 Stopping box |

IEC 085/01

Figure 23 – Sealing test for stopping boxes with setting compound

The hydraulic pressure is then progressively raised to a value of 20 bar for Group I and 30 bar for Group II, which shall be reached in a maximum of 1 min. The pressure shown by the gauge is observed for 2 min and no reduction of pressure shall be observed.

At the end of the test, the blotting paper shall be free from any trace of leakage.

NOTE It may be necessary to seal all joints of the test device other than those of the parts under test.

15.4 Tests of flameproof enclosures with breathing and draining devices

The tests in accordance with 15.4.1 to 15.4.3 shall be carried out in the following order on a sample after the impact strength test of 10.8.

For devices with non-measurable paths, the maximum bubble test pore size of the sample shall not be less than 85 % of the specified maximum bubble test pore size. See annex B.

15.4.1 Tests of ability of the enclosure to withstand pressure

The tests shall be made in accordance with 15.1 with the following additions and modifications.

15.4.1.1 For the determination of the explosion pressure in accordance with 15.1.2, breathing and draining devices shall be replaced by solid plugs.

15.4.1.2 For the overpressure test in accordance with 15.1.3 a thin flexible membrane (for example, a thin plastic sheet) shall be fitted to the inner surfaces of the breathing and draining devices. After the overpressure test, the device shall show no permanent deformation or damage, affecting the type of protection.

15.4.2 Thermal tests

15.4.2.1 Test procedure

The enclosure with the device(s) fitted shall be tested in accordance with the method 15.4.3.1 but with the ignition source only in the position giving the most unfavourable thermal results.

The temperature of the external surface of the device(s) shall be monitored during the test. The test shall be carried out five times. The test mixture to be used shall be $(4,2 \pm 0,1)$ % propane in volumetric ratio with air and at atmospheric pressure. Additionally, for devices intended for use in acetylene, $(7,5 \pm 1)$ % 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 external explosive mixture shall be maintained for a sufficient time to allow any continuous burning on the face of the device to become evident (for example, for at least 10 min so as to increase the temperature of the external surface of the device or to make heat transfer to the outer face possible).

15.4.2.2 Acceptance criterion

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

15.4.3 Test for non-transmission of an internal ignition.

This test shall be made in accordance with 15.2 with the following additions and modifications.

15.4.3.1 Test procedure

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

15.4.3.2 Non-transmission test for breathing and draining devices

For breathing and draining devices of Groups I, IIA and IIB the non-transmission test of 15.2.1 shall be applied.

For breathing and draining devices of Group IIC with measurable paths, 15.2.2 and either 15.4.3.2.1 or 15.4.3.2.2 is to be applied. For breathing and draining devices of Group IIC with non-measurable paths, 15.4.3.2.1 or 15.4.3.2.2 is to be applied.

15.4.3.2.1 Method A

For devices intended for use only in hydrogen, only the test with the hydrogen/air mixture is required. The tests are carried out five times with each test mixture. The tests are made according to 15.2.2.2 and 15.4.3.1.

15.4.3.2.2 Method B

The use of this method involves limitation of the range of Group IIC gases covered. The restriction of use shall be indicated accordingly, as specified in 27.2e) of IEC 60079-0.

Where exclusion of a specific gas or gases is required, the apparatus shall be marked "X".

Carbon disulphide is excluded for enclosures with a volume greater than 100 cm³.

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

- a) (40 ± 1) % hydrogen, (20 ± 1) % oxygen and the rest nitrogen;
- b) (10 ± 1) % acetylene, (24 ± 1) % oxygen and the rest nitrogen.

The tests shall be carried out five times with each test mixture, in accordance with 15.4.3.1.

For devices intended for use only in hydrogen, only test mixture a) is to be used.

15.4.3.3 Acceptance criterion

The test result is considered satisfactory if no ignition is transmitted to the test chamber.

16 Routine tests

16.1 The following routine tests are intended to ensure that the enclosure withstands the pressure and also that it contains no holes or cracks connecting to the exterior.

The routine tests include an overpressure test made according to one of the methods described for the type tests in 15.1.3. The method is to be agreed between the manufacturer and the testing station.

16.1.1 The routine overpressure test may be made by the first method even when the overpressure type test has been made by the second method.

When the determination of the reference pressure has been impracticable and when a dynamic test involves a risk to the enclosed apparatus (windings, etc.), the static pressures to be applied are as follows:

Volume cm ³	Group	Pressure bar
≤10	I, IIA, IIB, IIC	10
>10	I	10
>10	IIA, IIB	15
>10	IIC	20

16.1.2 When the second method is chosen, the routine test consists of

- either an explosion test with, inside and outside the enclosure, the appropriate explosive mixture specified in 15.1.2 (for the determination of explosion pressure) at 1,5 times atmospheric pressure;
- or a dynamic overpressure test as described in 15.1.3.2 for type tests, followed by a non-transmission test with explosive mixtures as specified in 15.2.1.2 or 15.2.2.1 (test for non-transmission of an internal ignition, with enlarged gaps) inside and outside the enclosure at atmospheric pressure;
- or a dynamic overpressure test as described in 15.1.3.2 for type tests, followed by a static test at a pressure of at least 2 bar.

16.1.3 For the routine test, it is sufficient to test the enclosure empty. However, if the routine test is dynamic and the enclosed apparatus influences the pressure rise during an internal explosion, the test conditions shall be decided by agreement between the manufacturer and the testing station.

The individual parts of a flameproof enclosure (for example, cover and base) can be tested separately. The test conditions shall be such that the stresses are comparable to those to which these parts are exposed in the complete enclosure.

16.2 Routine tests are not required for enclosures with a volume less than or equal to 10 cm³. This exception also applies to enclosures with a volume greater than 10 cm³ when the prescribed type test has been made at a static pressure of four times the reference pressure. However, enclosures of welded construction shall in every case be submitted to the routine test.

For enclosures where reference pressure measurement is impractical, exemption from routine pressure testing shall not apply.

Routine tests are not required for bushings not specific to one flameproof enclosure, if the assembly procedure is sufficiently documented (see 13.4.4).

16.3 The routine tests are considered satisfactory if

- the enclosure withstands the pressure without suffering permanent deformation of the joints or damage to the enclosure, and,
- when the test has been made by the dynamic followed by the static tests of 16.1.2, there is no leakage through the walls of the enclosure or, if made dynamically, there is no transmission of an internal ignition.

17 Switchgear for Group I

Group I flameproof enclosures which are to be opened from time to time on site, for example, for adjustment purposes or for resetting of protection relays, and which contain remotely operated switching devices in which circuits can be made or broken by a separate influence (which may be mechanical, electrical, electro-optical, pneumatic, acoustic, magnetic, or thermal) when this influence is not applied manually to the apparatus itself, and which produce in service arcs or sparks capable of igniting an explosive mixture, shall comply with the following requirements.

17.1 Means of isolation

All accessible conductors, except those of intrinsically safe circuits complying with IEC 60079-11 and those for bonding or earthing, shall be capable of being isolated from the supply before the opening of the flameproof enclosure.

The means of isolation of these flameproof enclosures shall be in accordance with 17.1.1, 17.1.2 or 17.1.3.

17.1.1 Fitted inside the flameproof enclosure, in which case the parts which remain energized after the means of isolation has been opened shall either

- be protected by one of the standard types of protection listed in IEC 60079-0 or
- shall have clearances and creepage distances between phases and to earth in accordance with the requirements of IEC 60079-7, and be protected by an enclosure that provides a degree of protection of at least IP20 according to IEC 60529 arranged so that a tool cannot contact the energized parts through any openings. This does not apply to parts of intrinsically safe circuits complying with IEC 60079-11 which remain energized.

In either case, a warning label "DO NOT OPEN WHEN ENERGIZED" shall be provided on the cover protecting the parts which remain energized.

17.1.2 Fitted inside another enclosure complying with one of the standard types of protection listed in IEC 60079-0.

17.1.3 A plug and socket or a cable coupler complying with the requirements of 13.3.

17.2 Doors or covers

17.2.1 Quick-acting doors or covers

These doors or covers shall be mechanically interlocked with an isolator so that

17.2.1.1 the enclosure retains the properties of the flameproof enclosure, type of protection "d", as long as the isolator is closed and

17.2.1.2 the isolator can only be closed when these doors or covers ensure the properties of the flameproof enclosure, type of protection "d".

17.2.2 Doors or covers fixed by screws

These doors or covers shall bear a label "DO NOT OPEN WHEN ENERGIZED".

17.2.3 Threaded doors or covers

These doors or covers shall bear a label "DO NOT OPEN WHEN ENERGIZED".

18 Lampholders and lampcaps

The following requirements apply to lampholders and lampcaps which together have to form a flameproof enclosure, type of protection "d", so that they may be used in luminaires of increased safety, type of protection "e".

18.1 Device preventing lamps working loose

The device which prevents lamps working loose, required in annex A of IEC 60079-7, increased safety "e", may be omitted for threaded lampholders provided with a quick-acting switch in a flameproof enclosure, type of protection "d", which breaks all poles of the lamp circuit before contact separation.

18.2 Holders and caps for lamps with cylindrical caps

18.2.1 Holders and caps for tubular fluorescent lamps shall comply with the dimensional requirements of data sheets Fa6 of IEC 60061.

18.2.2 For other holders, the requirements of clause 5 shall apply, but the width of the flameproof joint between the holder and the cap shall be at least 10 mm at the moment of contact separation.

18.3 Holders for lamps with threaded caps

18.3.1 The threaded part of the holder shall be of a material which is resistant to corrosion under the likely conditions of service.

18.3.2 At the moment of contact separation during unscrewing of the lamp, at least two complete turns of the thread shall be engaged.

18.3.3 For threaded lampholders E26/E27 and E39/E40, electrical contact shall be established by spring-loaded contact elements. In addition, for electrical apparatus of Group IIB or IIC, the making and breaking of contact during insertion and removal of the lamp, shall take place within a flameproof enclosure, type of protection "d", of Group IIB or IIC respectively.

NOTE For threaded lampholders E10 and E14, the requirements of 18.3.3 are not necessary.

19 Non-metallic enclosures and non-metallic parts of enclosures

The following requirements apply to non-metallic enclosures and non-metallic parts of enclosures, except for

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

19.1 Permitted non-metallic enclosures

Non-metallic enclosures are permitted

- if their free volume is $\leq 3\,000\text{ cm}^3$;
- without limitation of volume if the enclosure is partly made of non-metallic material and if the surface area of each of the parts of non-metallic material does not exceed 500 cm^2 ; however, the light transmitting part of a luminaire may have a surface area not exceeding $8\,000\text{ cm}^2$.

19.2 Special constructional requirements

19.2.1 Resistance to tracking and creepage distances on internal surfaces of the enclosure walls

When an enclosure or a 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 shall comply with the requirements of IEC 60079-7.

However, for enclosures of electrical apparatus of Group I which may be subjected to electrical stresses capable of producing arcs in air and which result from rated currents of more than 16 A, the requirements stated in 12.6 are to be observed.

19.3 Supplementary requirements for type tests

The type tests according to 23.4 of IEC 60079-0 shall be supplemented by the tests which are indicated in 19.3.1 and 19.3.2.

19.3.1 Tests for flameproofness

19.3.1.1 Test procedure

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 23.4.7 of IEC 60079-0.

19.3.1.2 Tests of ability of the enclosure to withstand pressure

These tests shall be made as specified in 15.1.

19.3.1.3 Test of erosion by flame

This test shall be made only on enclosures of volume greater than 100 cm³ and of which the flameproof joints have at least one face of plastics material. For this test

- static gaps of flanged joints and plane parts of spigot joints of the enclosure shall be set to a value between 0,1 mm and 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 15.1.2.1 for the corresponding group. In the case of electrical apparatus of Group IIC, 25 ignitions shall be made with each of the two explosive mixtures specified in 15.1.2.1.

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

19.3.1.4 Test for non-transmission of an internal ignition

This test shall be carried out as specified in 15.2.

19.3.2 Flammability

This test shall be carried out only for enclosures or parts of enclosures of plastic materials.

19.3.2.1 The test shall be carried out in accordance with ISO 1210.

The test pieces shall

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

The test pieces moulded 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.

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

The time during which any 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).

19.3.2.2 If the test in 19.3.2.1 is not applicable due to distortion of the test piece out of flame one of the following tests shall be applied.

19.3.2.2.1 First alternative test method

The burning test is to be conducted in a chamber, enclosure or laboratory hood that is free from draughts. 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 × 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 $(9,5 \pm 0,5)$ mm. The tube shall not be equipped with end attachments such as a stabilizer.

The gas should be technical grade methane gas with suitable regulator and meter for uniform gas flow. (Natural gas having a heat content of approximately 37 MJ/m³ has been found to provide similar results.)

The test specimens shall be (125 ± 5) mm in length, $(13 \pm 0,3)$ mm in width and $(4 \pm 0,2)$ 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.