

Electrical apparatus for potentially explosive atmospheres — Flameproof enclosure ‘d’

The European Standard EN 50018:2000, with the incorporation of amendment A1:2002, has the status of a British Standard

ICS 29.260.20

National foreword

This British Standard is the official English language version of EN 50018:2000, including amendment A1:2002. It supersedes BS EN 50018:1995, BS 5501-5:1977 and BS 5000-17:1981, which are withdrawn.

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**Electrical apparatus for potentially explosive atmospheres -
Flameproof enclosure 'd'**
(includes amendment A1:2002)

Matériel électrique pour atmosphères
explosibles -
Enveloppe antidéflagrante 'd'
(inclut l'amendement A1:2002)

Elektrische Betriebsmittel für
explosionsgefährdete Bereiche -
Druckfeste Kapselung 'd'
(enthält Änderung A1:2002)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by SC 31-2, Flameproof enclosures 'd', of Technical Committee CENELEC TC 31, Electrical apparatus for explosive atmospheres.

It consists of the text of EN 50018:1994 and three amendments (prAA, prAB and prAC) which were submitted to the Unique Acceptance Procedure and approved by CENELEC on 2000-04-01 for publication as a new edition of the standard.

This European Standard supersedes EN 50018:1994.

This European standard was prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of the EC Directive 94/9/EC.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2001-04-01
- latest date by which the national standards
conflicting with the EN have to be withdrawn (dow) 2003-06-30

This European Standard is to be read in conjunction with EN 50014:1997 - Electrical apparatus for potentially explosive atmospheres - General requirements, and with the European Standards for the specific types of protection listed in the scope of EN 50014:1997. This European Standard should not be considered with any other editions of these standards and their amendments.

Annexes designated "normative" are part of the body of the standard. Annexes designated "informative" are given only for information. In this standard, annexes A, B, C, D and E are normative.

Foreword to amendment A1

This amendment to the European Standard EN 50018:2000 was prepared by SC 31-2, Flameproof enclosures 'd', of Technical Committee CENELEC TC 31, Electrical apparatus for explosive atmospheres.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A1 to EN 50018 on 2001-06-01.

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- latest date by which the amendment has to be
implemented at national level by publication of an
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conflicting with the amendment to be withdrawn (dow) 2003-06-30

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GENERAL

1 Scope

1.1 This European Standard contains the specific requirements for the construction and testing of electrical apparatus with type of protection flameproof enclosure 'd', intended for use in potentially explosive atmospheres.

1.2 This European Standard supplements the European Standard EN 50014, the requirements of which apply to electrical apparatus with flameproof enclosure.

1.3 This European Standard covers only Category M2 and 2.

1.4 Due to the safety factors incorporated in the type of protection 'd' the uncertainty of measurement inherent in good quality, regularly calibrated measurement equipment is considered to have no significant detrimental effect and need not to be taken into account when making any measurements necessary to verify the compliance of the enclosure with the requirements of this standard.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 50014	1997	Electrical apparatus for potentially explosive atmospheres — General requirements.
EN 50019	2000	Electrical apparatus for potentially explosive atmospheres — Increased safety 'e'.
EN 50020	1994	Electrical apparatus for potentially explosive atmospheres — Intrinsic safety 'i'.
EN 50039	1980	Electrical apparatus for potentially explosive atmospheres — Intrinsically safe electrical systems 'i'.
EN 60061	Series	Lamp caps and holders together with gauges for the control of interchangeability and safety.
EN 60061-1	1993	Part 1: Lamp caps. (IEC 60061-1:1969 + supplements A:1970 to N:1992, modified)
EN 60061-2	1993	Part 2: Lampholders. (IEC 60061-1:1969 + supplements A:1970 to K:1992, modified)
EN 60086-1	2001	Primary batteries — Part 1: General (IEC 60086-1:2000)
EN 60127	Series	Miniature fuses (IEC 60127)
EN 60285	1994	Alkaline secondary cells and batteries — Sealed nickel-cadmium cylindrical rechargeable single cells (IEC 60285:1993 + corr. August 1993) ^{A1}
EN 60529	1991	Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)



EN 60623	1995	Vented nickel-cadmium prismatic rechargeable single cells (IEC 60623:1990 + A1:1992 + A2:1992)
EN 60662	1993	High pressure sodium vapour lamps (IEC 60662:1980 + A2:1987 + A3:1990)
EN 60695-11-10	1999	Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods (IEC 60695-11-10:1999).



EN 61150	1993	Alkaline secondary cells and batteries — Sealed nickel-cadmium rechargeable monobloc batteries in button cell design (IEC 61150:1992)
HD 214 S2	1980	Recommended method for determining the comparative tracking index of solid insulating materials under moist conditions (IEC 60112:1979).
IEC 60079-1A	1975	Electrical apparatus for explosive gas atmospheres — Part 1: Construction and test of flameproof enclosures of electrical apparatus First supplement: Appendix D: Method of test for ascertainment of maximum experimental safe gap.
ISO 31-0	1992	Quantities and units — Part 0: General principles.
ISO 185	1988	Grey cast iron — Classification.
ISO 468	1982	Surface roughness — Parameters, their values and general rules for specifying requirements.
ISO 965-1	1998	ISO general purpose metric screw threads; Tolerances; Part 1: Principles and basic data.
ISO 965-3	1998	ISO general purpose metric screw threads; Tolerances; Part 3: Deviations for constructional threads.
ISO 1210	1982	Plastics — Determination of flammability characteristics of plastics in the form of small specimens in contact with a small flame.
ISO 2738	1999	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 at ambient temperature.

3 Definitions

The following definitions specific to type of protection flameproof enclosure 'd' are applicable in this European Standard; they supplement the definitions which are given in EN 50014.

3.1

flameproof enclosure 'd'

type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure 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 corresponding surfaces of two parts of an enclosure come together, or the conjunction of enclosures, and prevent 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 (i)

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 width which prevents any transmission of an explosion in ten 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

3.16

Ex stopping plug

threaded stopping device tested separately from the apparatus enclosure but certified as apparatus and which can be fitted to the apparatus enclosure during installation without further certification

3.17

Ex thread adapter

thread adapter tested separately from the enclosure but certified as apparatus and which can be fitted to the apparatus enclosure during installation without further certification. This does not preclude the component certification of thread adapters in accordance with EN 50014. Examples of thread adapters are shown in Figure C.2

4 Apparatus grouping and temperature classification

The apparatus grouping and temperature classification defined in EN 50014 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.

SPECIFIC CONSTRUCTIONAL REQUIREMENTS

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 1 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.

NOTE 2 Coating with paint 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 Table 1 and Table 2. The width of joint for cylindrical metallic parts press-fitted into the walls of a metallic flameproof enclosure of 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 EN 50014, taking the worst case interference fit tolerances into account; and
- the external diameter of the press-fitted part, where the width of joint is measured, does not exceed 60 mm.

5.2.2 Gap (i)

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

The surfaces of joints shall be such that their average roughness R_a (ISO 468) 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.

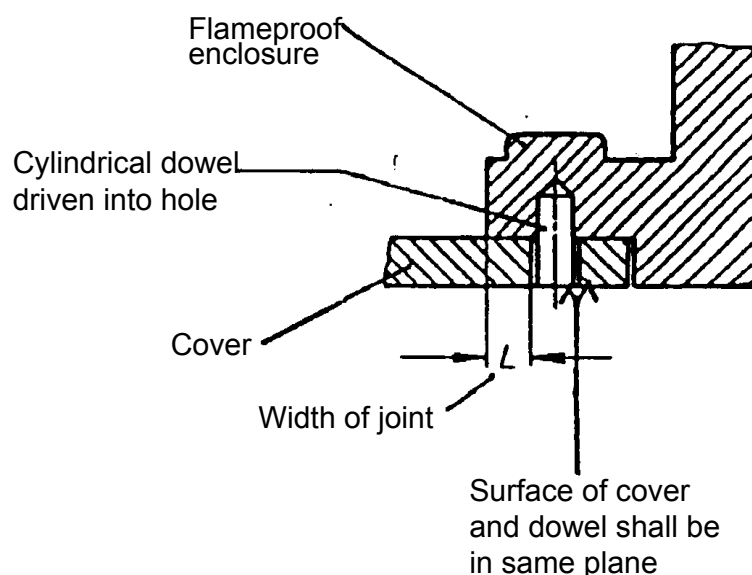


Figure 1 — Example of construction for indirect checking of a flanged Group I flameproof joint

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 Table 1 and Table 2.
- or the cylindrical part only (see Figure 3).
In this case the plane part need not comply with the requirements of Table 1 and Table 2.

NOTE For gaskets see also 5.4.

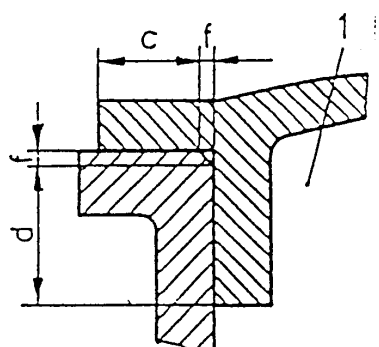


Figure 2

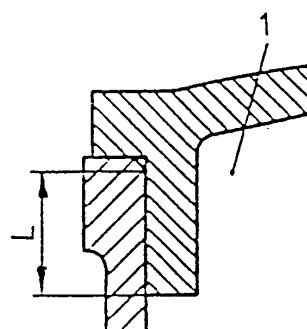


Figure 3

- $L = c + d$ (I, IIA, IIB, IIC)
 $c \geq 6,0 \text{ mm}$ (IIC)
 $\geq 3,0 \text{ mm}$ (I, IIA, IIB)
 $d \geq 0,50 L$ (IIC)
 $f \leq 1,0 \text{ mm}$ (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 Figure 4 and Figure 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.

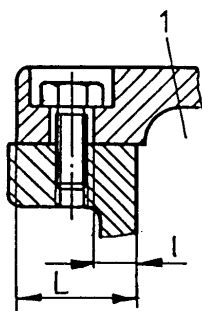


Figure 4

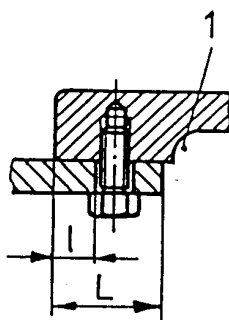


Figure 5

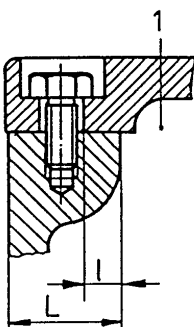


Figure 6

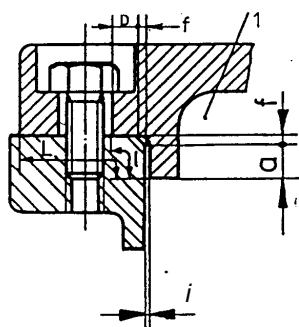


Figure 7

$i \leq 0,20$ mm (I, IIA)
 $i \leq 0,15$ mm (IIB)
 $i \leq 0,10$ mm (IIC)

1 Interior of enclosure

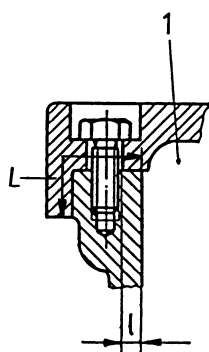


Figure 8

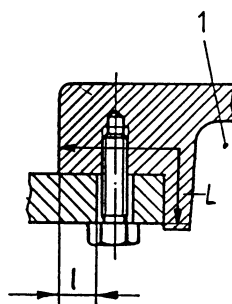


Figure 9

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 Figure 8 and Figure 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 joint, and the gap normal to the joint surfaces shall comply with the relevant values in Table 1 and Table 2. The gap shall be uniform through the conical part. For electrical apparatus of Group IIC, the cone angle shall not exceed 5° .

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.

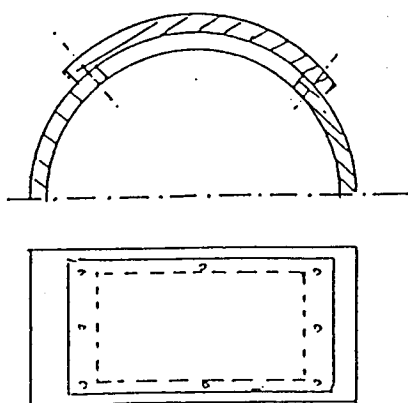


Figure 10 — Example for a joint with partial cylindrical surfaces

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; they are permitted for potentially explosive atmospheres containing no acetylene if the volume of the enclosure does not exceed 500 cm^3 .

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

Type of joint		Minimum width of joint <i>L</i> mm	Maximum gap in mm for Volume <i>V</i> (cm ³)											
			<i>V</i> ≤ 100			100 < <i>V</i> ≤ 500			500 < <i>V</i> ≤ 2 000			<i>V</i> > 2 000		
			I	IIA	IIB	I	IIA	IIB	I	IIA	IIB	I	IIA	IIB
Flanged, cylindrical or spigot joints For spigot joints, see Figure 2 and Figure 3		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 The 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 in mm for Volume V (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	-	-
Spigot joints $c \geq 6$ mm (Figure 2) $d_{\min} = 0,5 L$ $L = c + d$ $f \leq 1$ mm	12,5	0,15	0,15	0,15	
	25	0,18 ²⁾	0,18 ²⁾	0,18 ²⁾	0,18 ²⁾
	40	0,20 ³⁾	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
	40	0,20	0,20	0,20	0,20
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/air. ²⁾ i_T of cylindrical part increased to 0,20 if $f \leq 0,5$. ³⁾ i_T of cylindrical part increased to 0,25 if $f \leq 0,5$.					
NOTE The constructional values rounded according to ISO 31/0 should be taken when determining the maximum gap.					

5.3 Threaded joints

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

Table 3 — Cylindrical threaded joints

Pitch:	$\geq 0,7 \text{ mm}^{1)}$
Thread form and quality of fit:	medium or fine tolerance quality according to ISO 965-1 and ISO 965-3 ²⁾
Threads engaged:	≥ 5
Depth of engagement:	
Volume $\leq 100 \text{ cm}^3$	$\geq 5 \text{ mm}$
Volume $> 100 \text{ cm}^3$	$\geq 8 \text{ mm}$
¹⁾ Where the pitch exceeds 2 mm, special manufacturing precautions may be necessary (e.g. 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.	
²⁾ Cylindrical threaded joints which do not conform with the ISO standard, 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 threaded joint specified by the manufacturer is reduced by the amount specified in Table 6.	

Table 4 — Taper threaded joints

Pitch	$\geq 0,9 \text{ mm}$
Threads provided on each part	≥ 6
The internal and external thread shall have the same cone angle and thread form, which shall be defined.	
Taking the maximum permissible tolerances, the actual number of engaged threads may be less than five.	

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. See Figures 11 to 16.

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.

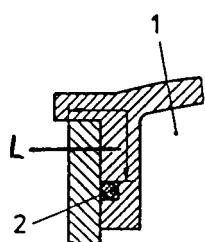


Figure 11

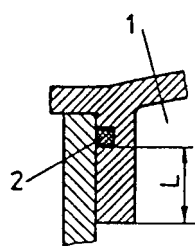


Figure 12

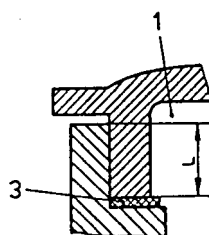


Figure 13

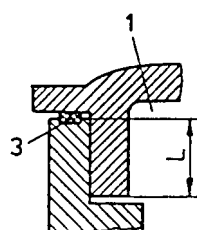


Figure 14

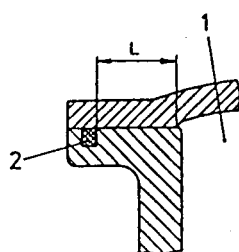


Figure 15

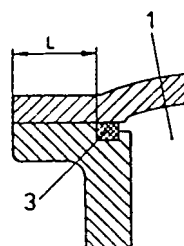


Figure 16

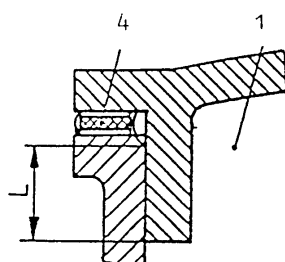


Figure 17

- 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. See Figure 17.

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 in EN 50014:1997.

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 and application time 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:

$\geq 3 \text{ mm}$ if	$V \leq 10 \text{ cm}^3$
$\geq 6 \text{ mm}$ if	$10 \text{ cm}^3 < V \leq 100 \text{ cm}^3$
$\geq 10 \text{ mm}$ 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 joint specified in Table 1 and Table 2, the width of joint shall be at least equal to this diameter but without, however, having to exceed 25 mm.

7.2 If the diametral 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, e.g. by means of a replaceable bush. Alternatively, gap enlargement due to wear may be prevented by 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 Figure 18 and Figure 21), or
- a labyrinth joint (see Figure 19 and Figure 21), or
- a joint with a floating gland (see Figure 20).