

INTERNATIONAL STANDARD



Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"



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IEC 60079-1

Edition 7.0 2014-08
REDLINE VERSION

INTERNATIONAL STANDARD



Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.260.20

ISBN 978-2-8322-1850-1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60079-1
Edition 7.0 2014-06

EXPLOSIVE ATMOSPHERES –

Part 1: Equipment protection by flameproof enclosures "d"

INTERPRETATION SHEET 1

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

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

DISH	Report on voting
31/1536/DISH	31/1542/RVDISH

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.

IEC 60079-1:2014 Edition 7.0, Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"

Question 1:

The requirements given in 13.1 of IEC 60079-1:2014 (Edition 7) restrict threaded entries for flameproof enclosures to only metric and NPT. Does this restriction represent a major technical change between IEC 60079-1:2014 (Edition 7) and IEC 60079-1:2007 (Edition 6)?

Answer 1:

Yes, the restriction to only metric and NPT regarding threaded entries for flameproof enclosures does represent a major technical change between IEC 60079-1:2014 (Edition 7) and IEC 60079-1:2007 (Edition 6). The requirements given in Clause 13 of IEC 60079-1:2007 (Edition 6) had no such normative restriction, with reference to metric and NPT only as examples of threaded entries for flameproof enclosures.

While IEC 60079-1:2014 (Edition 7) only permits the use of metric and NPT threads for entry into flameproof enclosures, cable glands/conduit entry devices, thread adapters and blanking elements are permitted to use other thread forms (see Annex C of IEC 60079-1:2014 (Edition 7)).

NOTE 1 The intention of the restriction to only metric and NPT regarding threaded entries for flameproof enclosures is to minimize the mismatch of thread forms in enclosure entries.

NOTE 2 In the Foreword of IEC 60079-1:2014 (Edition 7), the table detailing the significance of the changes between IEC 60079-1:2014 (Edition 7) and IEC 60079-1:2007 (Edition 6) mistakenly did not identify this metric and NPT restriction as a major technical change. Unfortunately, the IEC Directives do not permit a corrigendum to be issued to correct errors in non-normative text such as the table detailing the significance of changes.

Question 2:

Where a thread adapter is fitted and assessed as a factory-assembled part of the flameproof enclosure, what are the permitted thread forms?

Answer 2:

A thread adapter may use thread forms other than metric and NPT, whether as an Ex Equipment thread adapter or as a thread adapter fitted and assessed as a factory-assembled part of the flameproof enclosure (see Annex C of IEC 60079-1:2014 (Edition 7)).

Question 3:

Can a blanking element be installed in a thread adapter which is fitted and assessed as a factory-assembled part of the flameproof enclosure?

Answer 3:

Yes, the requirements given in Clause 13 of IEC 60079-1:2014 (Edition 7) regarding thread adapters are for separately certified Ex equipment thread adapters, not those fitted and assessed as a factory-assembled part of the flameproof enclosure.

Question 4:

What is the required marking when a thread adapter is fitted and assessed as a factory-assembled part of the flameproof enclosure?

Answer 4:

Clause 13 of IEC 60079-1:2014 (Edition 7) requires identification of the specific thread type and size of threaded entries into flameproof enclosures. In the case where the thread adapter is fitted and assessed as a factory-assembled part of the flameproof enclosure, the requirement for identification applies to the thread form of the adapter for the field wiring connection.

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EXPLOSIVE ATMOSPHERES –

Part 1: Equipment protection by flameproof enclosures “d”

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International Standard IEC 60079-1 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This seventh edition cancels and replaces the sixth edition, published in 2007, and constitutes a technical revision.

The significance of the changes between IEC 60079-1, Edition 7.0 (2014) and IEC 60079-1 Edition 6.0 (2007) (including Corrigendum 1 (2008)), is as listed below:

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Normative references (Removal of the edition date from the reference for IEC 60079-0)	2	X		
Requirements for level of protection “da” (Catalytic sensors of portable combustible gas detectors)	4.2		X	
Requirements for level of protection “dc” (“Enclosed break” devices from IEC 60079-15)	4.4, 15.5	X		
Flameproof joints, General requirements (Documentation clarification and examples of corrosion inhibiting grease)	5.1	X		
Flameproof joints, General requirements (Specific Conditions of Use that joints are not intended to be repaired)	5.1		X	
Flameproof joints, General requirements (Electroplating more than 0,008 mm thick)	5.1		X	
Non-threaded joints, Gap (<i>i</i>) (Intentional gaps between surface for flanged joints)	5.2.2	X		
Serrated joints (Use and test requirements)	5.2.8	X		
Multi-step joints (Not less than 3 adjacent segments and two path changes)	5.2.9		X	
Minimum width of joint and maximum gap for enclosures of groups IIA and IIB (Maximum gaps for flanged, cylindrical or spigot joints of 9,5 mm minimum width and volume greater than 2 000 cm ³)	Table 2		X	
Minimum width of joint and maximum gap for enclosures of groups I, IIA, IIB and IIC (ISO 80000-1 for constructional value rounding)	Table 2, Table 3	X		
Cylindrical threaded joints (ISO 965-1 standard in respect of thread form or quality of fit)	Table 4	X		
Taper threaded joints (External and internal thread construction)	Table 5	X		
Cemented joints (Supplemental mechanical means of securement)	6.1.2			C1
Cemented joints (Evaluation criteria if there is leakage)	6.1.2		X	
Fused glass joints (Glass-to-metal joints)	6.2		X	

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Thermal tests of breathing and draining devices (Temperature class based on external surface temperature after the 10 min test period)	10.9.3.2	X		
Test of the ability of the breathing and draining device to withstand pressure (Relocated from before thermal tests to after the non-transmission test)	10.9.3.4	X		
Ex component certificate (Service temperature range for non-metallic enclosures per IEC 60079-0)	10.9.4	X		
Fasteners and openings (Relocation of blanking element content to 13.8 and C.2.3)	11	X		
Fasteners and openings, Property class or yield stress (Certificate specific condition of use)	11.3	X		
Fasteners and openings (Openings in the wall of the enclosure)	11.8	X		
Materials (Material limitation in acetylene atmospheres)	12.8			C2
Entries for flameproof enclosures, General (Metric and NPT threaded entries)	13.1	X		
Entries for flameproof enclosures, General (Group I non-threaded joints)	13.1		X	
Entries for flameproof enclosures, Non-threaded holes (Group I application)	13.3		X	
Entries for flameproof enclosures, Cable glands (Group I application)	13.4		X	
Cable glands, Conduit sealing devices (Documentation to facilitate mounting)	13.4,13.5	X		
Plugs and sockets and cable couplers (Load requirement for arc-quenching test)	13.6.4			C3
Bushings (Documentation to facilitate mounting)	13.7	X		
Blanking elements (Relocated from Clause 11)	13.8	X		
Verification and tests (Maximum surface temperature conditions)	Table 6	X		
Type tests (Sequence and number of samples for tests)	15	X		
Determination of explosion pressure, General (Devices that can cause turbulence)	15.2.2.2	X		
Determination of explosion pressure, General (Number of tests for Group IIC)	15.2.2.2	X		
Determination of explosion pressure, General (Pressure pilling for Group IIB)	15.2.2.4	X		

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Determination of explosion pressure, General (<i>Equipment marked for a single gas</i>)	15.2.2.5	X		
Overpressure test, General (<i>Low ambient overpressure tests not required</i>)	15.2.3	X		
Overpressure test – First method (static) (<i>3 times option when routine batch testing</i>)	15.2.3.2		X	
Overpressure test – First method (static) (<i>Adjustment for low ambient due to small size of equipment</i>)	15.2.3.2		X	
Overpressure test – Second method (dynamic) (<i>Number of tests to be made</i>)	15.2.3.3	X		
Test for non-transmission of an internal ignition (<i>Clarification regarding grease</i>)	15.3	X		
Reduction in length of a threaded joint for non-transmission test (<i>ISO 965-1 and 965-3 standards in respect of thread form and quality of fit</i>)	Table 9	X		
Test factors to increase pressure or test gap (<i>Group IIC adjustments for elevated ambients</i>)	Table 10	X		
Test for non-transmission of an internal ignition, Groups I, IIA and IIB (<i>Number of tests to be made</i>)	15.3.2.3	X		
Test for non-transmission of an internal ignition, Group IIC testing by increased gap (<i>Number of tests to be made</i>)	15.3.3.2	X		
Test for non-transmission of an internal ignition, Group IIC (<i>Oxygen enrichment of test gases</i>)	15.3.3.4		X	
Thermal tests of enclosures with breathing and draining devices (<i>Temperature class based on external surface temperature after the 10 min test period</i>)	15.4.3.1	X		
Tests for “dc” devices (“Enclosed break” devices from IEC 60079-15)	15.5		X	
Routine tests, General (<i>Adjustment for low ambient due to small size of equipment</i>)	16.1.2		X	
Routine tests, General (<i>Options when second method is chosen</i>)	16.1.3	X		
Routine tests, General (<i>Welded joint inspection options</i>)	16.3		X	
Routine tests, General (<i>Allowance for batch testing</i>)	16.6		X	
Switchgear for Group I (<i>Clarifying need for compliance with EPL Mb types of protection</i>)	17.2.2, 17.2.3	X		
Non-metallic enclosures and non-metallic parts of enclosures, General (<i>Exception for cemented joints</i>)	19.1	X		

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Non-metallic enclosures and non-metallic parts of enclosures, Resistance to tracking and creepage distances (Reference to both IEC 60079-7 and or IEC 60079-15)	19.2		X	
Non-metallic enclosures and non-metallic parts of enclosures, Requirements for type tests (Clarification of test sequence)	19.3	X		
Instructions (Indication that repair of flamepaths is not intended)	21		X	
Bushings (Documentation regarding numbers of cores)	C.2.1.4	X		
Bushings (Criteria for non-transmission test)	C.2.1.4	X		
Bushings (Evaluation criteria if there is leakage)	C.2.1.4		X	
Flameproof joints, Threaded joints (Requirement options)	C.2.2.1	X		
Flameproof joints, Non-threaded joints (Group I application)	C.2.2.2		X	
Constructional requirements for Ex blanking elements (Relocated from Clause 11)	C.2.3.1	X		
Constructional requirements for Ex blanking elements (Metric and NPT Ex blanking elements)	C.2.3.2, C.2.3.3	X		
Constructional requirements for Ex blanking elements (Group I non-threaded construction)	C.2.3.4		X	
Sealing test, General (Allowance for re-tightening)	C.3.1.1	X		
Cable glands and conduit sealing devices with sealing ring (Mandrel to be corrosion-resistant metal)	C.3.1.2	X		
Type tests for Ex blanking elements, Torque test (Test-block to be steel)	C.3.3.1	X		
Tightening torque values (Addition of < 16 mm thread size)	Table C.1		X	
Tightening torque values (Addition of NPT thread sizes)	Table C.2		X	
Ex component enclosure requirements (Markings content)	D.3.8			C4
Ex component enclosure requirements (Certificate content)	D.3.10		X	
Utilization of an Ex component enclosure certificate to prepare an equipment certificate, Procedure (Devices that can create significant turbulence)	D.4.1		X	
Acceptable primary cells (Addition of Type B cells)	Table E.1		X	

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Acceptable primary cells (Removal of Type T cells)	Table E.1			C5
Acceptable secondary cells (Addition of Lithium type cells)	Table E.2		X	
Prevention of excessive temperature and cell damage (Application of IEC 60079-11 requirement)	E.4.1.2	X		
Prevention of inadvertent charging of a battery by other voltage sources in the enclosure (Construction not requiring additional protection)	E.4.3		X	
Recharging of secondary cells inside flameproof enclosures (Additional battery options)	E.5.1		X	
Introduction of an alternative risk assessment method encompassing equipment protection levels' for Ex equipment (Removal of previous Informative Annex)	Annex G	X		
Additional requirements for Flameproof enclosures with an internal source of release (containment system) (Addition of new Normative Annex)	Annex G		X	
Requirements for machines with flameproof "d" enclosures fed from converters (Addition of new Normative Annex)	Annex H		X	

NOTE The technical changes referred to include the significance of technical changes in the revised IEC Standard, but they do not form an exhaustive list of all modifications from the previous version. More guidance can be found by referring to the Redline Version of the standard.

Explanations:

A) Definitions

Minor and editorial changes

Clarification
decrease of technical requirements
minor technical change
editorial corrections

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

Extension

addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition.

Major technical changes

addition of technical requirements
increase of technical requirements

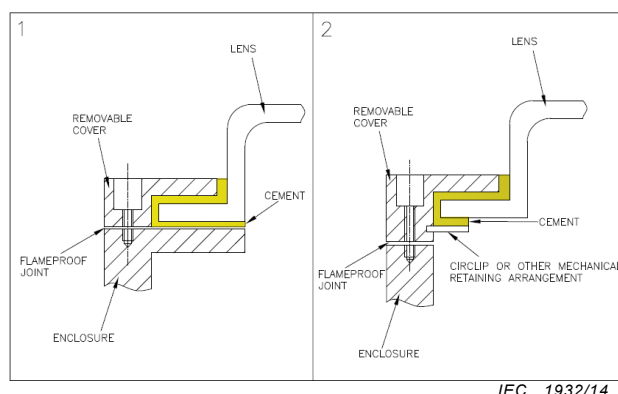
These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfil the requirements given in the later edition. These changes have to be

considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below.

NOTE These changes represent current technological knowledge. However, these changes should not normally have an influence on equipment already placed on the market.

B) Information about the background of 'Major Technical Changes'

C1 – Supplemental mechanical means of securing the cemented joint shall not be defeated by the opening of doors or covers that are intended to be opened during installation or maintenance. For example, in the images below for a luminaire incorporating a cemented joint between the lens and the enclosure cover, the construction shown in the second image would be in accordance with this requirement, while the construction shown in the first image would not.



C2 – Addition of material limitations of enclosures of equipment and enclosures of Ex components for external mounting, if constructed of copper or copper alloys, when used in explosive gas atmospheres containing acetylene (12.8).

C3 – Addition of power factor requirement for evaluating the ability of a plug and socket to remain flameproof during the arc-quenching period while opening a test circuit (13.6.4).

C4 – Addition of marking requirements for Ex component enclosures, in addition to the requirements for marking of Ex components given in IEC 60079-0 (D.3.8).

C5 – Removal of Type T cells as acceptable primary cells (Table E.1).

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

FDIS	Report on voting
31/1111/FDIS	31/1125/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 2.

A list of all parts in the IEC 60079 series, published under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

The contents of the corrigendum of June 2018 and Interpretation sheet of May 2020 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

EXPLOSIVE ATMOSPHERES –

Part 1: Equipment protection by flameproof enclosures “d”

1 Scope

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

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirement of this standard will take precedence.

~~NOTE Equipment protection by flameproof enclosures “d” provides Equipment Protection Level (EPL) Gb. For further information, see Annex G.~~

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

~~IEC 60079-0:2004, *Electrical apparatus for explosive gas Explosive* atmospheres – Part 0: *Equipment – General requirements*~~

~~IEC 60079-1-1, *Electrical apparatus for explosive gas atmospheres – Part 1-1: Flameproof enclosures “d” – Method of test for ascertainment of maximum experimental safe gap*~~

IEC 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety “e”*

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “i”*

~~IEC 60079-14:2002, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*~~

~~IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection “n”*~~

~~IEC 60086-1:2000, *Primary batteries – Part 1: General*~~

~~IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*~~

IEC 60127 (all parts), *Miniature fuses*

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

~~IEC 60623:2001, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells*~~

~~IEC 60662:1980, High-pressure sodium vapour lamps~~

~~IEC 60695-11-10, Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods~~

~~IEC 61951-1:2003, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Portable sealed rechargeable single cells – Part 1: Nickel-cadmium~~

~~IEC 61951-2:2003, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Portable sealed rechargeable single cells – Part 2: Nickel-metal hydride~~

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

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 **screw** threads

ISO 2738:~~1999~~, Sintered metal materials, excluding hardmetals – Permeable sintered metal materials – Determination of density, oil content and open porosity

~~ISO 3864: 1984, Safety colours and safety signs~~

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

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

ANSI/ASME B1.20.1-~~1983 (R2001)~~, Pipe threads, general purpose (inch)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 as well as the following apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426 [1]¹.

3.1

flameproof enclosure “d”

enclosure in which the parts which can ignite an explosive gas 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 gas atmosphere surrounding the enclosure

3.2

volume

total internal volume of the enclosure

Note 1 to entry: ~~However,~~ For enclosures in which the contents are essential in service, the volume to be considered is the remaining free volume.

Note 2 to entry: For luminaires, the volume is determined without lamps fitted.

¹ References in square brackets refer to the bibliography.

3.3**flameproof joint or flamepath**

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

Note 1 to entry: This definition does not apply to threaded joints.

3.5**distance***l*

shortest path through a flameproof joint, when the width of the flameproof 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

Note 1 to entry: 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 (for an explosive mixture)***MESG*

maximum gap of a joint of 25 mm in width which prevents any transmission of an explosion during 10 tests made under the conditions specified in IEC 60079-~~4-4-20-1~~ [2]

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

Note 1 to entry: The device is arranged so that the operation has two stages:

- one for locking or unlocking, and
- 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**

device which permits an exchange between the atmosphere within an enclosure and the surrounding atmosphere and which maintains the integrity of the type of protection

3.15**draining device**

device which permits liquids to flow out from an enclosure and which maintains the integrity of the type of protection

3.16**Ex equipment blanking element**

threaded blanking elements for Group I or II, and non-threaded blanking elements for Group I, that

- are intended to close unused entries,
- are tested separately from the equipment enclosure,
- have an equipment certificate, and
- are intended to be fitted to the equipment enclosure without further consideration

Note 1 to entry: This does not preclude a component certificate for Ex component blanking elements in accordance with IEC 60079-0. Examples of blanking elements are shown in Figure C.1.

Note 2 to entry: Non-threaded blanking elements are not equipment for Group II applications.

3.17**Ex equipment thread adapter**

thread adapter tested separately from the enclosure but having an equipment certificate and which is intended to be fitted to the equipment enclosure without further consideration

Note 1 to entry: This does not preclude a component certificate for Ex component thread adapters in accordance with IEC 60079-0. Examples of thread adapters are shown in Figure C.3.

3.18**Ex component enclosure**

empty flameproof enclosure provided with an Ex component certificate, without the internal equipment being defined, so as to enable the empty enclosure to be made available for incorporation into an equipment certificate without the need for repetition of type testing

~~4—Equipment grouping and temperature classification~~

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

4 Level of protection (equipment protection level, EPL)

4.1 General

Electrical equipment with flameproof enclosure “d” shall be one of the following:

- level of protection “da” (EPL “Ma” or “Ga”);
- level of protection “db” (EPL “Mb” or “Gb”); or
- level of protection “dc” (EPL “Gc”).

The requirements of this standard shall apply to all levels of protection unless otherwise stated.

4.2 Requirements for level of protection “da”

Level of protection “da” is only applicable to catalytic sensors of portable combustible gas detectors.

The following are the additional specific requirements for level of protection “da” that modify or supplement the requirements of this standard:

- the maximum free internal volume shall not exceed 5 cm³;
- the electrical conductors into the sensor shall employ a sealed joint, in accordance with Clause 6, directly in the wall of the enclosure;
- the breathing device of the sensor shall comply with Clause 10, and shall be bonded to the wall of the enclosure so as to eliminate any gaps (such as cementing per 6.1 or sinter bonding) or shall be press-fitted to the wall of the enclosure with supplemental mechanical means of securing (such as swaging);
- supplied by a circuit of Level of Protection “ia”, with a maximum dissipated power limited to 3,3 W for Group I and 1,3 W for Group II; and

NOTE Catalytic elements operate normally at a high temperature. If the power dissipation is increased beyond normal operating levels, the element fails to an open circuit. Therefore, the required power limitation provides a limitation of the external surface temperature.

- the non-transmission tests of 15.3 or 15.4.4 (if applicable) are modified to increase the number of non-transmission tests as shown in Table 1.

Table 1 – Number of non-transmission tests for level of protection “da”

Equipment group	Number of non-transmission tests
I	50
IIA	50
IIB	50
IIC	50 hydrogen and 50 acetylene

4.3 Requirements for level of protection “db”

Other than specific requirements for level of protection “da” and “dc”, all other requirements of this standard shall apply to level of protection “db”.

4.4 Requirements for level of protection “dc”

4.4.1 General

The requirements for level of protection “dc” are applicable to electrical equipment and Ex components with electrical switching contacts and are found in 4.4.2 through 4.4.3.

4.4.2 Construction of “dc” devices

4.4.2.1 General

The requirements of 4.4.2.2 through 4.4.2.5 replace those of Clause 5 through Clause 13. For equipment in level of protection “dc” that is intended for connection to field wiring, Clause 13 applies.

4.4.2.2 Free internal volume

The free internal volume shall not exceed 20 cm³.

4.4.2.3 Seal protection

Enclosures for level of protection “dc” that do not serve as the external equipment enclosure shall be capable of withstanding normal handling and assembly operations without damage to seals. When the enclosure for level of protection “dc” also serves as the external equipment enclosures, the enclosure requirements of IEC 60079-0 apply.

4.4.2.4 Continuous operating temperature (COT) requirements

Poured seals and encapsulating compounds shall have a continuous operating temperature (COT) range that includes a minimum temperature that is below, or equal to, the minimum service temperature and a maximum temperature that is at least 10 K above the maximum service temperature.

4.4.2.5 Ratings

Devices shall be limited to a maximum rating of 690 V a.c., r.m.s. or d.c. and 16 A a.c. r.m.s. or d.c.

4.4.3 Tests for “dc” devices

For devices involving level of protection “dc”, components shall be subjected to the type test specified in 15.5. After the test, the device or component shall show no visible signs of damage, no external ignition shall occur, and there shall be no failure to clear the arc when the switch contacts are opened.

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.

~~The dimensions given in 5.2 to 5.5 inclusive specify the minimum or maximum values that may be applied to the essential parameters of flamepaths. In instances where a dimension of a flameproof joint is other than the relevant minimum or maximum (for example, in order to comply with the test for non-transmission of an internal ignition), the equipment shall be marked “X” according to 29.2 item i) of IEC 60079-0 and the specific conditions of use on the certificate shall be in accordance with one of the following:-~~

The dimensions given in 5.2 to 5.5 specify the essential parameters of flamepaths. In instances where any of the following apply (for example, in order to comply with the test for non-transmission of an internal ignition):

- the minimum length of the flameproof joint as stated by the documentation is greater than the relevant minimum; or
- the maximum gap of the flameproof joint as stated by the documentation is less than the relevant maximum; or
- the minimum number of threads engaged for the flameproof joint as stated by the documentation is more than the relevant minimum;

NOTE 1 IEC 60079-0 defines the documentation as the documents that give a full and correct specification of the explosion safety aspects of the electrical equipment.

the equipment certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the specific conditions of use listed on the certificate and in the instructions shall detail one of the following:

- dimensions of the flameproof joints shall be detailed; or
- specific drawing referenced that details the dimensions of the flameproof joints; or
- specific guidance noted to contact the original manufacturer for information on the dimensions of the flameproof joints; or
- specific indication that the flameproof joints are not intended to be repaired.

NOTE 2 IEC 60079-0 permits the use of an advisory marking on the equipment as an alternative for the requirements for the "X" marking.

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.

Corrosion inhibiting grease, such as petrolatum or soap-thickened mineral oils, may be applied to joint surfaces before assembly. The grease, if applied, shall be of a type that does not harden because of ageing, does not contain an evaporating solvent, and does not cause corrosion of the joint surfaces. Verification of suitability shall be in accordance with the grease manufacturer's specifications.

Joint surfaces may be electroplated. The metal plating, if applied, shall ~~not be more than 0,008 mm thick~~ be in accordance with the following:

- if not more than 0,008 mm thick, no additional consideration is necessary;
- if more than 0,008 mm thick, then the maximum gap without the plating shall still be in accordance with the applicable joint requirements, and shall be tested for flame transmission based on the gap dimension that would exist without the plating.

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 2 and 3.

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

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

NOTE There is no prohibition of press-fit combinations of other than metallic parts into metallic flameproof enclosures. In these other combinations, the minimum width of joint requirements of Tables 2 or 3 apply.

5.2.2 Gap (i)

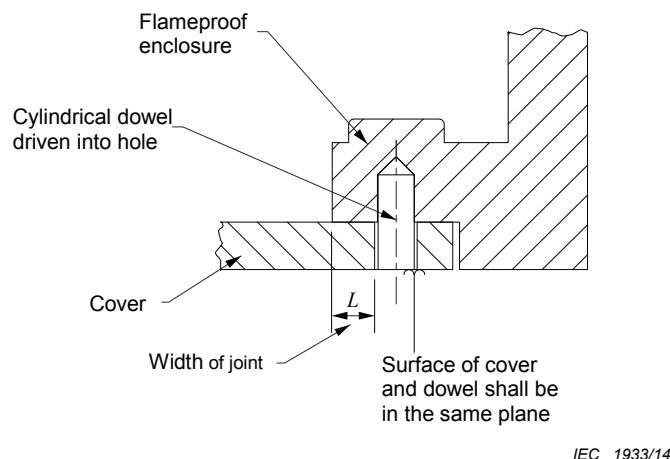
The gap, if one exists, between the surfaces of a joint shall nowhere exceed the maximum values given in Tables 2 and 3.

The surfaces of joints shall be such that their average roughness R_a ~~(derived from ISO 468)~~ does not exceed $6,3 \mu\text{m}$.

NOTE Average roughness is derived from ISO 468. Determination can be made by visual comparison to a reference plate.

For flanged joints of other than quick-acting doors or covers, there shall be no intentional gap between the surfaces **other than that created by the flatness tolerances of the mating parts**.

For electrical equipment 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.



IEC 1933/14

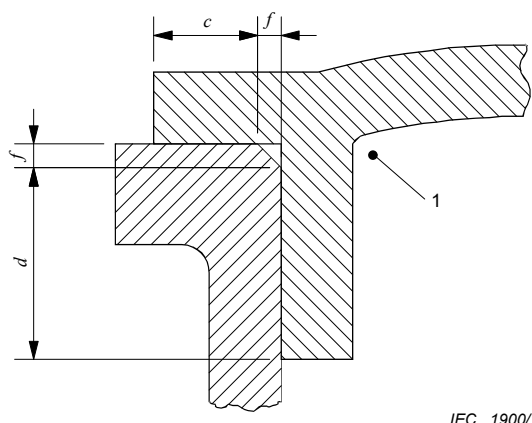
Figure 1 – Example of construction for indirect checking of a flanged Group I flameproof joint

5.2.3 Spigot joints

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

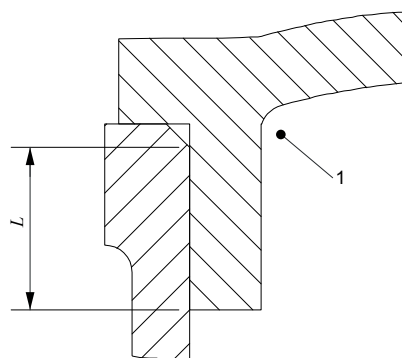
- the cylindrical part and the plane part (see Figure 2a). In this case, the gap shall nowhere exceed the maximum values given in Tables 2 and 3; or
- the cylindrical part only (see Figure 2b). In this case, the plane part need not comply with the requirements of Tables 2 and 3.

NOTE For gaskets, see also 5.4.



IEC 1900/14

Figure 2a – Cylindrical part and plane part



IEC 1901/14

Figure 2b – Cylindrical part only

Key

$$L = c + d \text{ (I, IIA, IIB, IIC)}$$

$$c \geq 6,0 \text{ mm (IIC)}$$

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

$$d \geq 0,50 L \text{ (IIC)}$$

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

1 interior of enclosure

Figure 2 – Spigot joints

5.2.4 Holes in joint surfaces

5.2.4.1 General

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

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

NOTE The requirements for clearance holes of fasteners are specified in IEC 60079-0.

The distance l is determined as follows.

5.2.4.2 Flanged joints with holes outside the enclosure (see Figures 3 and 5)

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

5.2.4.3 Flanged joints with holes inside the enclosure (see Figure 4)

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

5.2.4.4 Spigot joints where, to the edges of the holes, the joint consists of a cylindrical part and a plane part (see Figure 6)

The distance l is defined as follows:

- 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 equipment of Groups I and IIA, 0,15 mm for electrical equipment of Group IIB, or 0,1 mm for electrical equipment of Group IIC (reduced gap); or

- the width b of the plane part alone, if either of the above-mentioned conditions is not met.

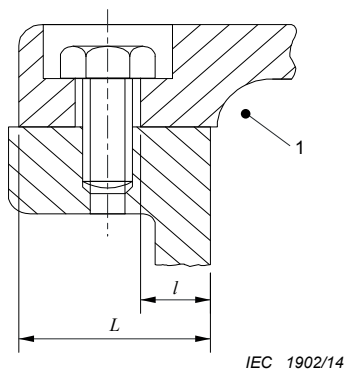


Figure 3 – Holes in surfaces of flanged joints, example 1

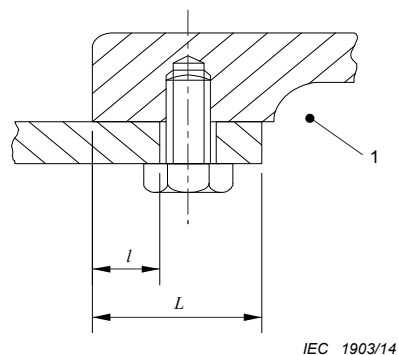


Figure 4 – Holes in surfaces of flanged joints, example 2

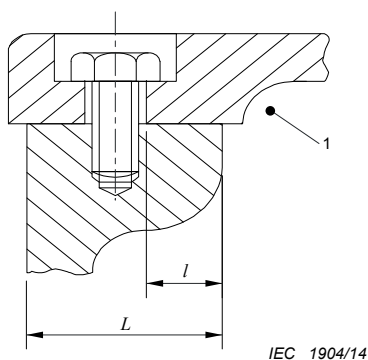


Figure 5 – Holes in surfaces of flanged joints, example 3

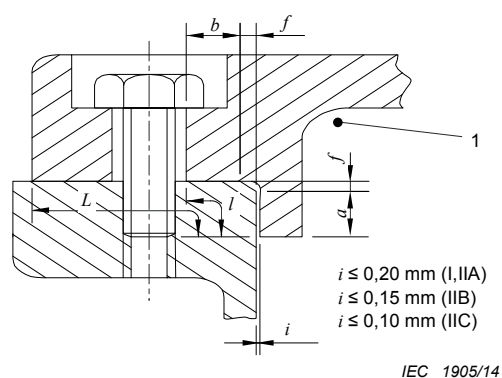
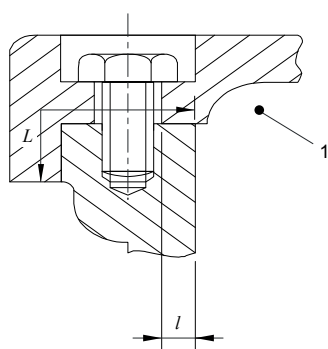
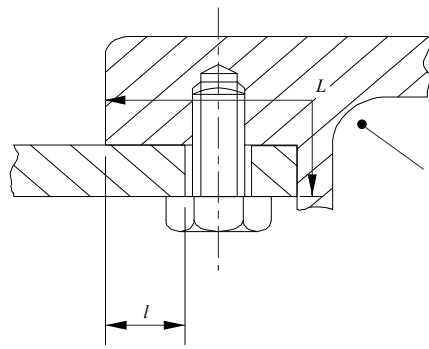


Figure 6 – Holes in surfaces of spigot joints, example 1



IEC 1906/14

Figure 7 – Holes in surfaces of spigot joints, example 2



IEC 1907/14

Figure 8 – Holes in surfaces of spigot joints, example 3

Key

1 interior of enclosure

5.2.4.5 Spigot joints where, to the edges of the holes, the joint consists only of the plane part (see Figures 7 and 8), 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 7), or between a hole and the outside of the enclosure where the hole is inside the enclosure (see Figure 8).

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 Table 2 and Table 3. The gap shall be uniform through the conical part. For electrical equipment of Group IIC, the cone angle shall not exceed 5° .

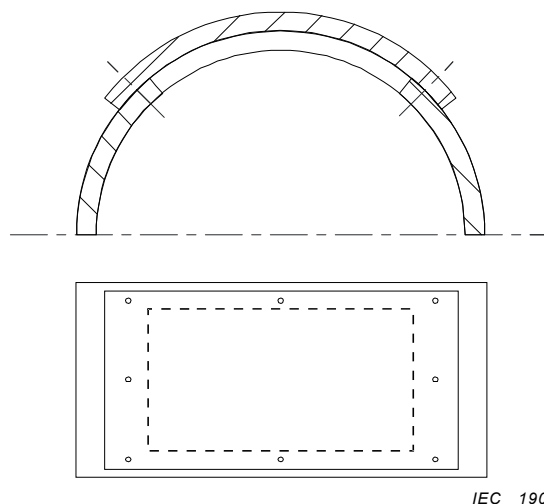
NOTE The cone angle is taken to be the angle between the major axis of the cone and the surface of the cone.

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 9a).

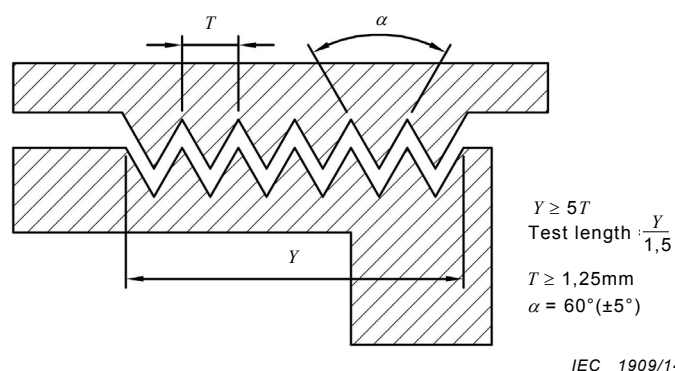
The width of the joint shall comply with the requirements of Table 2.

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 2.



IEC 1908/14

Figure 9a – Example of a joint with partial cylindrical surfaces



IEC 1909/14

Figure 9b – Example of serrated joint

Figure 9 – Examples of joint constructions

5.2.7 Flanged joints for acetylene atmospheres

Flanged joints are only permitted for electrical equipment of Group IIC intended for use in explosive gas atmospheres containing acetylene provided all of the following conditions are met:

- gap $i \leq 0,04$ mm;
- width $L \geq 9,5$ mm; and
- volume ≤ 500 cm³.

5.2.8 Serrated joints

Serrated joints need not comply with the requirements of Tables 2 and 3 but shall have

- at least five fully engaged serrations,
- a pitch greater than or equal to 1,25 mm, and
- an included angle of $60^\circ (\pm 5^\circ)$.

Serrated joints shall ~~not only~~ be used for ~~moving parts~~ joints that are fixed in place during operation.

Serrated joints shall satisfy the test requirements of 15.3, with a) the test gap, i_E , between the mating serrations as specified in 15.3, based on the manufacturer's maximum constructional gap, i_C , and b) the test length reduced to $Y / 1,5$.

If the manufacturer's maximum constructional gap is different to that shown in Tables 2 or 3 for a flanged joint of the same length (determined by multiplying the pitch by the number of serrations), the "conditions of use" requirements of 5.1 apply.

See Figure 9b.

5.2.9 Multi-step joints

A multi-step joint shall consist of not less than 3 adjacent segments where the path changes direction not less than two times by $90^\circ \pm 5^\circ$.

Multi-step joints need not comply with the requirements of Tables 2 or 3 but shall satisfy the test requirements of 15.3 with the test length of each segment reduced to not more than 75 % of the manufacturer's specified design minimum lengths.

For flameproof enclosures that incorporate multi-step joints, the equipment certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the specific conditions of use listed on the certificate shall detail one of the following:

- dimensions of the flameproof joints shall be detailed; or
- specific drawing referenced that details the dimensions of the flameproof joints; or
- specific guidance noted to contact the original manufacturer for information on the dimensions of the flameproof joints; or
- specific indication that the flameproof joints are not intended to be repaired.

NOTE 1 IEC 60079-0 permits the use of an advisory marking on the equipment as an alternative for the requirements for the "X" marking.

NOTE 2 Multi-step joints are distinct from labyrinth joints on rotating shafts as addressed in this standard (see 8.1.3).

Table 2 – 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 a volume cm^3 $V \leq 100$			For a volume cm^3 $100 < V \leq 500$			For a volume cm^3 $500 < V \leq 2\,000$			For a volume cm^3 $2\,000 < V \leq 5\,750$			For a volume cm^3 $V > 5\,750$		
			I	IIA	IIB	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	0,08	0,08	0,08	–	0,08	0,08	–	0,08	–
		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	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	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	–	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	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	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	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	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	0,80	0,75	0,40

NOTE Constructional values rounded according to ISO ~~31-0~~ 80000-1 [3] should be taken into consideration when determining the maximum gap.

NOTE In this edition of IEC 60079-1, two new columns were introduced into Table 2 that subdivided the previous single " $V > 2\,000$ " column into a " $2\,000 < V \leq 5\,750$ " column and a " $V > 5\,750$ " column. This subdivision was made to introduce maximum gap dimensions for flanged, cylindrical or spigot joints with minimum width of joint L of 9,5 mm where none existed previously. Specifically, it introduced the values "0,08" for Groups IIA and IIB when volume is " $2\,000 < V \leq 5\,750$ " and "0,08" for Group IIA when volume is " $V > 5\,750$ ". These maximum gap values and the associated volume subdivisions are based on historic US Class I, Division 1 explosion-proof gap dimensions documented in ANSI/UL 1203 [4].

Table 3 – Minimum width of joint and maximum gap for Group IIC enclosures

Type of joint		Minimum width of joint L mm	Maximum gap mm			
			For a volume cm^3 $V \leq 100$	For a volume cm^3 $100 < V \leq 500$	For a volume cm^3 $500 < V \leq 2\,000$	For a volume cm^3 $V > 2\,000$
Flanged joints ^a		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 2a)	$c \geq 6 \text{ mm}$	12,5	0,15	0,15	0,15	–
	$d \geq 0,5 L$	25	0,18 ^b	0,18 ^b	0,18 ^b	0,18 ^b
	$L = c + d$	40	0,20 ^c	0,20 ^c	0,20 ^c	0,20 ^c
	$f \leq 1 \text{ mm}$					
Cylindrical joints Spigot joints (Figure 2b)		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
^a Flanged joints are permitted for explosive mixtures of acetylene and air only in accordance with 5.2.7.						
^b Maximum gap of cylindrical part increased to 0,20 mm if $f < 0,5 \text{ mm}$.						
^c Maximum gap of cylindrical part increased to 0,25 mm if $f < 0,5 \text{ mm}$.						
NOTE The constructional values rounded according to ISO-31-0 80000-1 should be taken into consideration when determining the maximum gap.						

5.3 Threaded joints

Threaded joints shall comply with the requirements given in Tables 4 or 5.

Table 4 – 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 mm
Volume >100 cm ³	≥ 8 mm
^a Where the pitch exceeds 2 mm, special manufacturing precautions may be necessary (for example, more threads engaged) to ensure that the electrical equipment can pass the test for non-transmission of an internal ignition which is prescribed in 15.3.	
^b Cylindrical threaded joints which do not conform with ISO 965-1 and ISO 965-3 in respect of thread form or quality of fit are permitted if the test for non-transmission of an internal ignition, prescribed in 15.3, is passed, when the width of the threaded joint specified by the manufacturer is reduced by the amount specified in Table 9.	

Table 5 – Taper threaded joints ^{a, c}

Threads provided on each part	≥ 5 ^b
^a Internal and external thread shall have the same nominal size.	
^b Threads shall conform to the NPT requirements of ANSI/ASME B1.20.1 and shall be made-up wrench tight. ~~Male threaded fittings with a shoulder or interruption~~ External threaded parts shall be provided with: 1) an effective thread length not less than the “L2” dimension; and 2) if a shoulder is provided, a length not less than the “L4” dimension between the face of the shoulder and end of the ~~fitting~~ thread. Female Internal threads shall gauge at “flush” to “2 turns large” using an L1 plug-gauge.	
^c ~~Where the tapered threaded joint consists of both the internal and external threaded parts with at least 4,5 fully engaged threads, the requirements of footnote b in this table need not be applied.~~	
NOTE See Annex C for tapered thread requirements applicable to flameproof entry devices.	

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

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

These requirements do not apply to cable glands (see 13.4) 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 Figures 10 to 16.

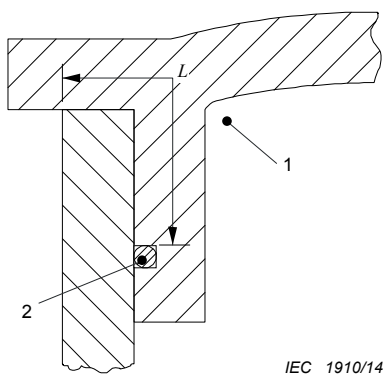


Figure 10 – Illustration of the requirements concerning gaskets – Example 1

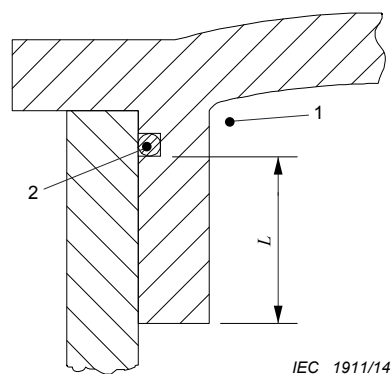


Figure 11 – Illustration of the requirements concerning gaskets – Example 2

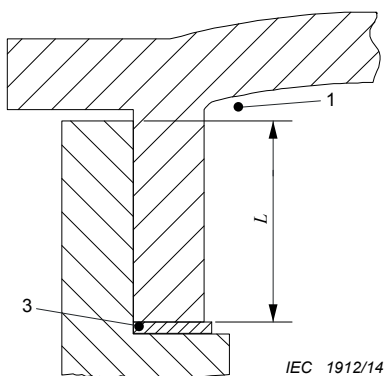


Figure 12 – Illustration of the requirements concerning gaskets – Example 3

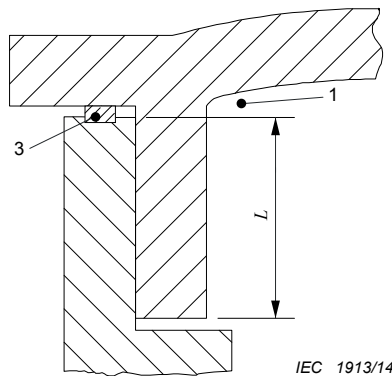


Figure 13 – Illustration of the requirements concerning gaskets – Example 4

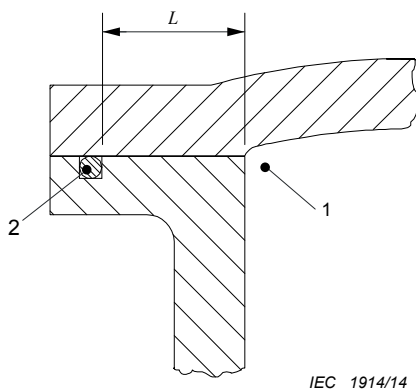


Figure 14 – Illustration of the requirements concerning gaskets – Example 5

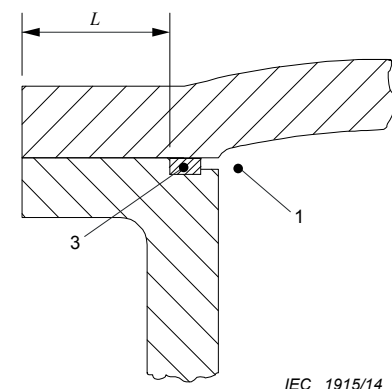
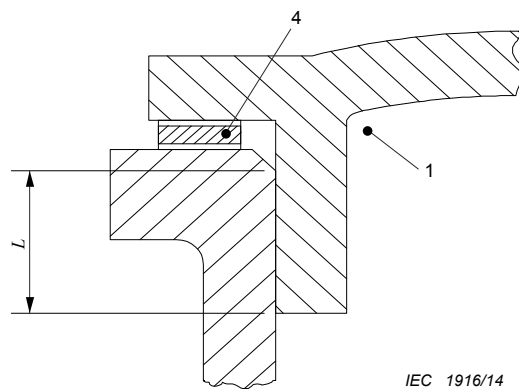


Figure 15 – Illustration of the requirements concerning gaskets – Example 6

**Key**

- 1 interior of enclosure
- 2 O-ring
- 3 gasket
- 4 metallic or metal sheath gasket

Figure 16 – Illustration of the requirements concerning gaskets – Example 7

5.5 Equipment using capillaries

The capillaries shall either comply with the gap dimensions given in Table 2 or Table 3 for cylindrical joints using 0 as the diameter of the inner part, or when the capillaries do not conform to the gaps given in these tables, the equipment shall be evaluated in accordance with the test for non-transmission of an internal ignition given in 15.3.

6 Sealed joints

6.1 Cemented joints

6.1.1 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 the thermal endurance to heat and thermal endurance to cold of IEC 60079-0.~~

~~The material, preparation, application, and curing conditions (such as time, temperature, etc.) of the cementing shall be included in documentation prepared in accordance with IEC 60079-0.~~

~~An unaltered sample of the cemented joint assembly representative of production shall be used for evaluation and testing purposes.~~

~~A flameproof joint in accordance with Clause 5, which also incorporates cement, and which is tested without the cement in accordance with 15.3, does not need to fulfill the requirements of Clause 6.~~

6.1.2 Mechanical strength

Cemented joints are only ~~permitted~~ **intended** 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 having overpressure and time in accordance with 15.1.3, with compliance criteria in accordance with C.3.1.1.~~ Supplemental mechanical means of securing the cemented joint shall not be defeated by the opening of doors or covers that are intended to be opened during installation or maintenance.

Cemented joints shall be subjected to the following tests:

- a) Two samples representative of production shall be subjected to an overpressure test with water in accordance with 15.2.3.2. The test is considered satisfactory if blotting paper, placed under each sample under test, is free from any trace of leakage.
- b) Either the same two samples from a) above, or a separate set of samples, shall be subjected to the tests of enclosures in IEC 60079-0, as applicable. Subsequent to this conditioning, the samples shall be subjected to an overpressure test with water in accordance with 15.2.3.2. The test is considered satisfactory if blotting paper, placed under each sample under test, is free from any trace of leakage.

NOTE The tests of enclosures in IEC 60079-0 permit the tests to be conducted on either a set of two samples or a set of four samples, with the difference being the number of tests conducted on each sample.

If there is any leakage on the blotting paper as a result of the test on the samples from 6.1.2 b), then the cemented joint for one sample that leaks after being subjected to the tests of enclosures and hydraulic pressure testing shall be subjected to the following tests:

- the flame erosion test in 19.4 but with no modifications to the cemented joints of the test samples, followed by
- the test for non-transmission in 15.3.2.1, or the test for non-transmission in 15.3.3.3 or 15.3.3.4, as applicable for the equipment group, with no further modifications to the cemented joints of the test sample.

The cemented joint is judged satisfactory if this test for non-transmission is satisfactory.

Routine overpressure testing of cemented joints (per Clause 16) shall be performed whenever 1,5 times or 3 times the reference pressure is necessary to comply with 6.1.2.

6.1.3 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 $V > 100 \text{ cm}^3$

6.2 Fused glass joints

6.2.1 General

Fused glass joints are glass-to-metal joints formed by the application of molten glass into a metal frame that results in either a chemical or physical bond between the glass and the metal frame.

6.2.2 Width of fused glass joints

The path through a fused glass joint from the inside to the outside of a flameproof enclosure shall be $\geq 3 \text{ mm}$.

7 Operating rods

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

- if the diameter of the operating rod exceeds the minimum width of the joint specified in Tables 2 and 3, the width of the joint shall be at least equal to this diameter but without, however, having to exceed 25 mm;
- 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 bushing. 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

8.1.1 General

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 17),
- a labyrinth joint (see Figure 18),
- a joint with a floating gland (see Figure 19).

8.1.2 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 17).

The minimum radial clearance k (see Figure 20) of shafts of rotating electrical machines shall not be less than 0,05 mm.

8.1.3 Labyrinth joints

Labyrinth joints which do not comply with the requirements of Tables 2 and 3 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 20) of shafts of rotating electrical machines shall not be less than 0,05 mm.

8.1.4 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 the gland shall remain concentric with the shaft. A device shall prevent rotation of the gland (see Figure 19).

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

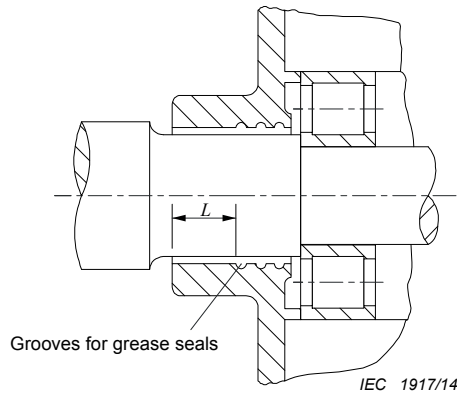


Figure 17 – Example of cylindrical joint for shaft of rotating electrical machine

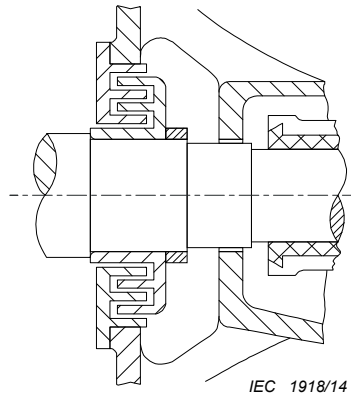
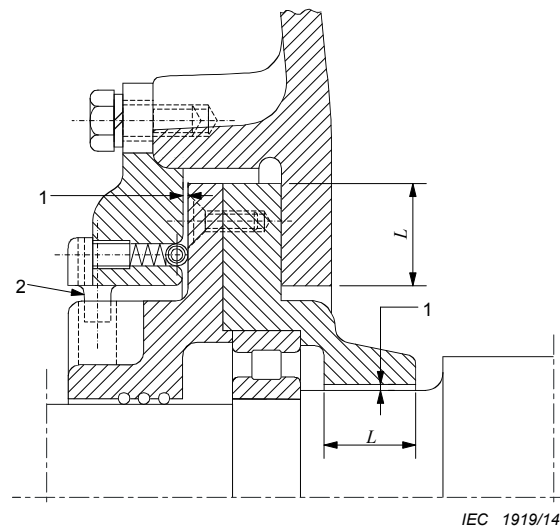


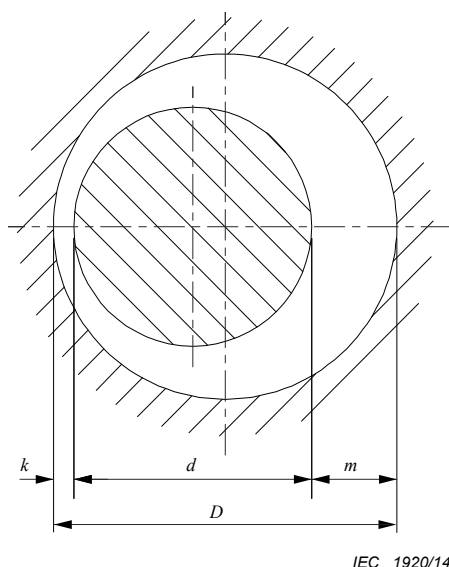
Figure 18 – Example of labyrinth joint for shaft of rotating electrical machine



Key

- 1 gap
- 2 stop to prevent rotation of gland

Figure 19 – Example of joint with floating gland for shaft of rotating electrical machine

**Key**

- k minimum radial clearance permissible without rubbing
- m maximal radial clearance taking k into account
- $D-d$ diametrical clearance

Figure 20 – 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 20) 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 IIC.

8.2.2 Rolling-element bearings

In shaft glands equipped with rolling-element bearings, the maximum radial clearance m (see Figure 20) shall not exceed two-thirds of the maximum gap permitted for such glands in Tables 2 and 3.

NOTE 1 It is acknowledged that, with assemblies, all parts will not exist in their worst case dimensions simultaneously. A statistical treatment of the tolerances, such as "RMS", ~~may~~ can be required for m and k verification.

NOTE 2 It is not a requirement of this standard that the manufacturer's m and k calculations be verified. Neither is it a requirement of this standard that m and k be verified by measurement.

9 Light-transmitting parts

For light-transmitting parts of other than glass, the requirements in Clause 19 of this standard apply.

NOTE ~~Precautions should be taken so that the~~ Mountings of light-transmitting parts, of any material ~~do not produce that produces~~ internal mechanical stress in those parts, ~~can result in failure of the light-transmitting part.~~

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

10.1 General

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,
- 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.

10.2 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).~~

NOTE Environmental contaminants (such as from the accumulation of dust or paint) can cause breathing and draining devices to become inoperative in service.

10.3 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 an explosive gas atmosphere containing acetylene shall comprise not more than 60 % of copper by mass to limit acetylide formation.

10.4 Dimensions

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

10.5 Elements with measurable paths

Interstices and measurable lengths of path need not comply with the values given in Tables 2 and 3, provided that the elements pass the tests of Clauses 14 through 16.

Additional requirements for crimped ribbon elements and multiple screen elements are given in Annex A.

10.6 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).~~

10.7 Removable devices

10.7.1 General

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

10.7.2 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 shall 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 of IEC 60079-0.

10.9 Breathing devices and draining devices when used as Ex components

10.9.1 General

In addition to 10.1 through 10.7 inclusive, the following requirements shall apply to breathing and draining devices which are evaluated as Ex components.

10.9.2 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.

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

10.9.3.1 General

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 10.9.3.2 to 10.9.3.4.

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 maximum bubble test pore size of the sample shall be not less than 85 % of the specified maximum bubble test pore size. See B.1.2.

~~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 at least 10 s. Then each component shall be submitted to a routine test; or~~
- ~~— 4 times the reference pressure for a period of at least 10 s. 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.~~

10.9.3.2 Thermal tests

10.9.3.2.1 General

After the bubble test in 10.9.3, breathing and draining devices as Ex components shall be subjected to the thermal tests based on the maximum intended flameproof enclosure volume, but no less than the volume of the test rig in Figure 21.

NOTE When using the test rig in Figure 21, the maximum volume ~~can be calculated to be~~ is approximately 2,5 l.

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

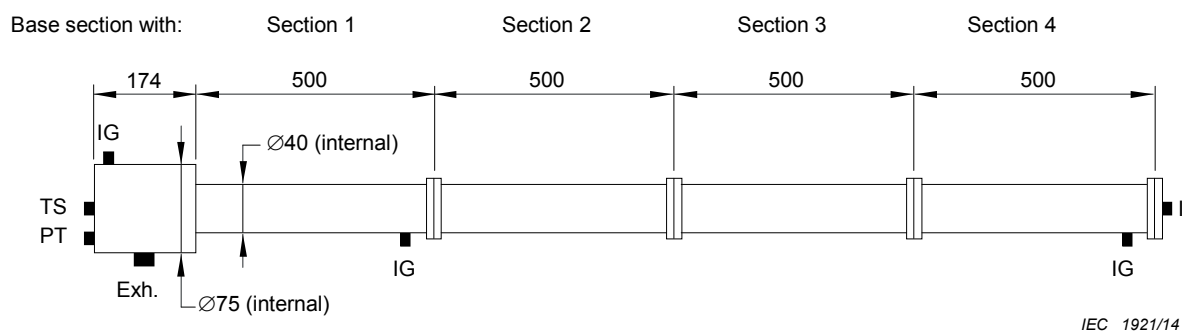
10.9.3.2.2 Test procedure

For enclosure volumes of less than or equal to 2,5 l, the test rig assembly with all four sections, as shown in Figure 21, 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 15.4.3.1, 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; and

NOTE The temperature of the external surface after the 10 min test period is used in determining the temperature class in accordance with 10.9.3.3.3.

- the tests shall be carried out five times for each gas mixture for the gas groups in which the device is intended for use.



Key

- TS test sample position
- I inlet
- Exh. exhaust outlet
- IG ignition source
- PT pressure transducer

Figure 21 – Component test rig for breathing and draining devices

For enclosure volumes of greater than 2,5 l, a representative enclosure of the intended volume shall be used, and the test procedure shall be carried out as follows:

- the test mixtures shall be as for 15.4.3.1, 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; and
- the tests shall be carried out five times for each gas mixture for the gas groups in which the device is intended for use.

10.9.3.2.3 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 and added to the maximum service temperature of the device for the determination of the temperature class of the electrical equipment.

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

10.9.3.3 Test for non-transmission of an internal ignition

10.9.3.3.1 General

After the bubble test in 10.9.3, this test shall be carried out on a standard test rig, as illustrated in Figure 21, and made in accordance with 15.4.4, with the following additions and modifications.

10.9.3.3.2 Test procedure

The position of the ignition source shall be as shown in Figure 21:

- a) at the inlet end; and
- b) 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, 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 15.3.2 shall be applied.

For breathing and draining devices of Group IIC with measurable paths, the non-transmission test of 15.3.3 and either 15.4.4.3.2 or 15.4.4.3.3 shall be applied.

For breathing or draining devices of Group IIC with non-measurable paths, 15.4.4.3.2 (method A) or 15.4.4.3.3 (method B) shall be applied.

10.9.3.3.3 Acceptance criteria

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

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

10.9.3.4.1 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 at least 10 s. Then each component shall be submitted to a routine test; or
- 4 times the reference pressure for a period of at least 10 s. If this test is successful, the manufacturer is not required to apply the routine test to all future components of the tested type.

10.9.3.4.2 Acceptance criteria

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

10.9.4 Ex component certificate

The Ex component certificate shall ~~record all~~ include, in the schedule of limitations, the details necessary to properly select a breathing or draining device for attachment to a type tested flameproof enclosure. ~~The Ex component certificate shall show~~ The schedule of limitations shall include, as a minimum, the following:

- ~~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 is 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.~~

- a) the maximum recorded surface temperature obtained during the type test corrected to 40 °C, or to the higher marked ambient;
- ~~a) the group, i.e. I, IIA, IIB, or IIC;~~
- ~~b) service temperature range for non-metallic enclosures and non-metallic parts of enclosures;~~
- c) the maximum permitted enclosure volume (based on the thermal test) if greater than 2,5 l;
- d) ~~In addition, the Ex component certificate shall require a requirement~~ that each Ex component or package of Ex components be accompanied by a copy of the certificate, together with the manufacturer's declaration stating
 - compliance with the certificate conditions, and
 - confirmation of the material, maximum bubble test pore size and minimum density, where applicable; and
- e) special mounting instructions, if any.

11 Fasteners, ~~associated holes and blanking elements and openings~~

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, with the head shrouded or provided in counter-bored holes or inherently protected by the equipment construction,
- for Group II, be special fasteners complying with the requirements of IEC 60079-0.

NOTE For Group I applications, the intent behind requiring shrouding or counter-boring is to provide some basic protection of the fastener head from impact.

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

11.3 In carrying out the type tests specified in Clause 15, the screws and nuts specified by the manufacturer shall be used.

The property class of the screw or nut, or yield stress and type of the screw or nut, used during testing shall be either:

- marked on the equipment in accordance with Table 14, point a), or
- specified in the relevant certificate **as a specific condition of use.**

NOTE See Annex F for additional informative details on mechanical properties for screws and nuts.

11.4 Studs shall comply with 11.3 and shall be securely fixed, i.e. they shall be welded or riveted or permanently attached to the enclosure by another equally effective method.

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. Openings, other than for entry devices, may be provided in the wall of a flameproof enclosure for optional installation of devices such as pushbuttons. If the optional device is not installed in the resulting opening at the time of manufacturing, the opening shall be closed by a device such that the flameproof properties of the enclosure are maintained.~~

NOTE The thread forms for these openings are not restricted to those specified for entry devices (see Clause 13).

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

~~Blanking elements shall comply with Annex C.~~

~~The blanking element 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 it 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 (see Figure 22b).~~

~~11.9.3 It may be of a special construction in which insertion is carried out 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).~~

~~11.9.4 A blanking element shall not be used with an adapter.~~

11.9 Threaded doors or covers shall be additionally secured by means of a hexagon socket set screw, or some equally effective method.

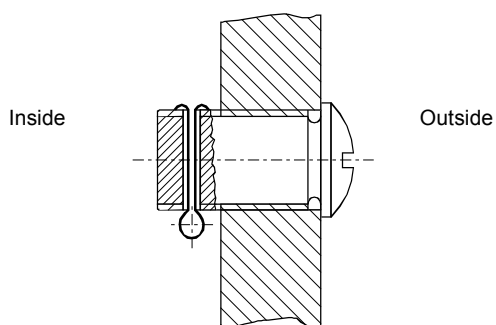


Figure 22a

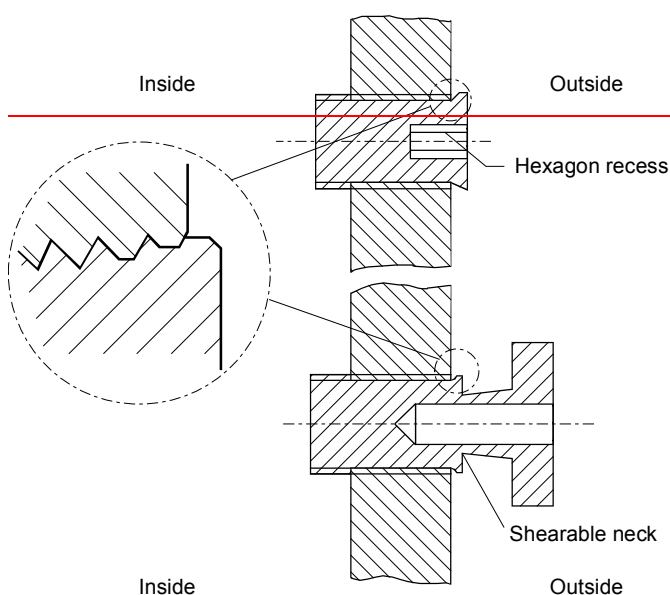


Figure 22b

Figure 22c

IEC—544/07

Figure 22 — Examples of blanking elements 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.

NOTE Cast iron quality 150 is defined by ISO 185.

12.5 Liquids shall not be used in flameproof enclosures when there is a risk of producing oxygen, or 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 equipment 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 equipment such as circuit-breakers, contactors, isolators) shall have a comparative tracking index equal to or greater than CTI 400 M.

NOTE CTI is determined in accordance with 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.

12.7 Flameproof enclosures shall not be made of zinc, or made of zinc alloy of 80 % zinc or greater.

NOTE Zinc and zinc alloys tend to deteriorate rapidly (particularly tensile strength), especially in warm, moist air. It is also considered more reactive than most other metals. As such, the restriction above was implemented.

12.8 In explosive gas atmospheres containing acetylene, enclosures of equipment and enclosures of Ex components for external mounting, if constructed of copper or copper alloys:

- shall be coated with tin, nickel, or by other coatings; or
- shall have the maximum copper content of the alloy limited to 60 %.

Flameproof entry devices as defined in Annex C are not considered an enclosure surface requiring coating or copper content restriction.

NOTE The restriction of the use of copper in acetylene atmospheres is due to the potential formation of acetylides on the surface that can be ignited by friction or impact.