UL 1203

STANDARD FOR SAFETY

ExplosionProof and Dust-IgnitionProof Electrical Equipment for Use in Hazardous (Classified) Locations

UL Standard for Safety for ExplosionProof and Dust-IgnitionProof Electrical Equipment for Use in Hazardous (Classified) Locations, UL 1203

Sixth Edition, Dated July 10, 2023

Summary of Topics

This revision of ANSI/UL 1203 dated May 30, 2024 adds a marking for component enclosures that have been tested for explosion pressure and propagation effects of short-circuit testing with circuit breakers; 59.23 and 59.24

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new requirements are substantially in accordance with Proposal(s) on this subject dated February 2, 2024 and April 26, 2024.

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The most recent designation of ANSI/UL 1203 as an American National Standard (ANSI) occurred on May 30, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

PART II – DUST-IGNITIONPROOF EQUIPMENT

CONSTRUCTION

PERFORMANCE

PART III – MANUFACTURING AND PRODUCTION TESTS

PART IV – MARKINGS AND INSTRUCTIONS

PART V – INDUSTRIAL CONTROL EQUIPMENT

CONSTRUCTION

PERFORMANCE

MARKINGS

PART VI – SWITCHES

CONSTRUCTION

RATINGS

MARKING

PART VII – CIRCUIT BREAKERS

CONSTRUCTION

MARKINGS

PART VIII – OUTLET BOXES AND FITTINGS

PERFORMANCE

PART IX – RECEPTACLE-PLUG COMBINATIONS

INTRODUCTION

CONSTRUCTION

PLUG

PLUG AND RECEPTACLE FOR FLAMMABLE ANESTHETIZING LOCATIONS

PERFORMANCE

ANNEX B (normative) – ALTERNATIVE EXPLOSION TESTS

ANNEX C (normative) – CELLS AND BATTERIES

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover explosionproof and dust-ignitionproof electrical equipment for installation and use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C, and D, and Class II, Division 1, Groups E, F, and G, in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements also cover explosionproof electrical equipment for installation and use in Class I, Zone 1, Groups IIA, IIB, and IIC hazardous (classified) locations and dust-ignitionproof equipment for use in Zone 20, 21, and 22 locations.

1.3 These requirements also cover explosionproof electrical equipment that has been investigated for use in one or more specific gas or vapor atmospheres with or without additional Class I Groups. See 59.6.

1.4 These requirements do not cover equipment for use in hazardous (classified) locations specifically covered in a separate standard.

1.5 These requirements cover equipment for use under the following atmospheric conditions:

a) A minimum ambient temperature of minus 60 °C (minus 76 °F);

b) An oxygen concentration not greater than 21 % by volume; and

c) A nominal barometric pressure of one atmosphere.

1.6 Equipment covered by this standard shall also comply with the applicable requirements for similar equipment for use in ordinary unclassified locations.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.5 Enclosures containing cells or batteries shall comply with Annex C.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ASME B1.1, *Unified Inch Screw Threads (UN and UNR Thread Form)*

ASME B1.20.1, *Pipe Taper (NPT) Thread*

ASME B46.1, *Surface Texture*

ASTM B858-06, *Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys*

ASTM E11, *Specification for Wire Cloth and Sieves for Testing Purposes*

ASTM E28, *Test Method for Softening Point by Ring-and-Ball Apparatus*

ASTM 1056, *Specification of Flexible Cellular Materials – Sponge or Expanded Rubber*

ASTM D256, *Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*

ASTM D395, *Test Methods for Rubber Property – Compression Set*

ASTM D790, *Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

ASTM E28, *Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus*

ISO 965-1, *General Purpose Metric Screw Threads – Tolerances – Part 1*

ISO 965-3, *General Purpose Metric Screw Threads*

NFPA, Health Care Facilities

UL 20, *General-Use Snap Switches*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 98, *Enclosed and Dead-Front Switches*

UL 157, *Gaskets and Seals*

UL 429, *Electrically Operated Valves*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*

UL 508, *Industrial Control Equipment*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 969, *Marking and Labeling Systems*

5 Enclosure Types

5.1 An enclosure that is intended for use in other environmental conditions shall also comply with the applicable requirements for each enclosure type, for example Type 3, 4X, or 6, specified in UL 50E.

5.2 A Type 3, 3R, 3S, 4, 4X, 6, or 6P enclosure is not prohibited from being marked "Raintight" when no water enters the enclosure or "Rainproof" when no water enters the enclosure at a point higher than the lowest live part. Compliance with these requirements shall be determined by the applicable tests in UL 50E.

6 Class I, Zone and Group Equivalency

6.1 Class I, Zone 1, Group IIA

6.1.1 Explosionproof electrical equipment intended to be marked in accordance with 59.4 shall comply with all the requirements for explosionproof electrical equipment for use in Class I, Group D hazardous (classified) locations.

6.2 Class I, Zone 1, Group IIB

6.2.1 Explosionproof electrical equipment intended to be marked in accordance with 59.5 shall comply with all the requirements for explosionproof electrical equipment for use in Class I, Group C hazardous (classified) locations.

6.3 Class I, Zone 1, Group IIC

6.3.1 Explosionproof electrical equipment intended to be marked in accordance with 59.7 shall comply with all the requirements for explosionproof electrical equipment for use in both Class I, Group A and Class I, Group B hazardous (classified) locations.

6.4 Zone 20 and Zone 21

6.4.1 Dust-ignitionproof electrical equipment intended to be marked in accordance with 59.10 shall comply with all the requirements for dust-ignitionproof electrical equipment for use in Class II, Division 1 hazardous (classified) locations.

7 Glossary

7.1 For the purpose of this Standard, the following definitions apply.

7.2 AXIAL JOINT SECTION – The portion of a flat, labyrinth, or rabbet joint that is parallel to the axis of the parts forming the joint.

7.3 CEMENTED JOINT – A joint which relies upon a cement or other similar compound to prevent the propagation of an explosion to a surrounding atmosphere by filling all voids between the mating parts

forming the joint, such that no flamepath exists. Intended for joints which are not disturbed after assembly. See 10.2.

7.4 CLEARANCE, AXIAL – The clearance between parts forming the axial joint section.

7.5 CLEARANCE, DIAMETRICAL – The clearance between two parts measured as the difference in the diameters.

7.6 CLEARANCE, RADIAL – The clearance between parts forming the joint section radiating from the axis or center.

7.7 FLAMEPATH – The joint formed upon assembly of parts that are intended to arrest the flame and vent hot gases produced when an ignition of an explosive atmosphere takes place within an explosionproof enclosure.

7.8 INTERNAL LENGTH OF JOINT – The distance from the innermost point to the outermost point of the joint formed upon assembly of the parts comprising that joint.

7.9 LABYRINTH JOINT – A joint consisting of an arrangement of mating steps, grooves or collars consisting of two or more axial sections having one radial section between each axial section, or two or more radial sections with one axial section between each radial section, whereby the flame path changes direction more than twice.

7.10 RABBET JOINT – A rabbet joint consists of an axial section and a radial section that form a right angle, whereby the flamepath must change direction. A rabbet joint is also known as a spigot joint.

7.11 RADIAL JOINT SECTION – The portion of the joint that is perpendicular to the axis of the parts forming the joint.

7.12 SEALED JOINT – A joint where a sealing material applied to a joint surface does not increase the maximum clearance between joint surfaces beyond the dimensions specified in this Standard. See 10.3.1, 16.5, and 16.6.

7.13 SHAFT PATH – A path formed upon assembly of a shaft and shaft opening in an enclosure.

7.14 STRAIGHT OR FLAT JOINT – A joint where, upon assembly of the parts forming the joint, a straight flame path in a single plane is formed.

7.15 TEST FACTOR – A factor of safety imposed upon a test condition.

7.16 THREADED JOINT – A joint formed upon assembly of two mating threaded sections.

7.17 BLANKING ELEMENT – Fitting intended to close unused field wiring entries. These fittings can also be referred to as close-up plugs.

7.18 THREAD ADAPTER – Fitting intended to allow a threaded fitting or conduit to be installed in an opening with a different thread. These fittings may be NPT-NPT, NPT-Metric, or Metric-Metric.

PART I – EXPLOSIONPROOF EQUIPMENT

CONSTRUCTION

8 Enclosure Material

8.1 The enclosure housing the electrical components, except those portions for viewing or light transmission, shall be made of iron, steel, copper, brass, bronze, or aluminum or aluminum alloys containing a minimum of 80 % aluminum, or shall be made of nonmetallic material which complies with the requirements in Section 33, Non-Metallic Enclosure Materials Tests. A metal such as zinc or zinc alloy, or magnesium or magnesium alloy, shall not be used.

8.2 Copper and copper alloys shall not be used for the enclosure of a device for use in Class I, Group A locations containing acetylene unless it is coated with tin, nickel, or other coating that has been determined to comply with the requirements or by limiting the maximum copper content of the alloy to 30 %.

8.3 A part for viewing or light transmission shall be made of glass or similar material.

9 Enclosure Thickness

9.1 Except as noted in 9.3 and 9.4, the minimum thickness of the metal enclosure walls shall be in accordance with Table 9.1.

9.2 A machined or a threaded joint in the walls of a cast-metal enclosure shall be not less than the minimum thickness specified in Table 9.1 through the overlap.

Table 9.1
Thickness of Metal for Enclosure

External enclosure dimensions				Minimum thickness, inch (mm)					
Length or diameter		Area of any one surface		Cast brass, bronze, copper, malleable iron		Cast iron and aluminum[a]		Sheet steel	
inches	(mm)	in^2	(dm^2)						
22	(559)	480	(31)	0.093	(2.36)	0.125	(3.18)	0.067	(1.70)
30	(762)	620	(40)	0.093	(2.36)	0.125	(3.18)	0.093	(2.36)
60	(1524)	1500	(97)	0.125	(3.18)	0.187	(4.75)	0.125	(3.18)
Over 60	(over 1524)	Over 1500	(over 97)	0.187	(4.75)	0.250	(6.35)	0.187	(4.75)

[a] Includes sand-cast, permanent-mold, and die-cast aluminum and sheet aluminum.

9.3 A component that closes an opening in the enclosure, such as a Bourdon tube, flexure tube, bellows, or diaphragm, and a nonmagnetic section of the enclosure required for proper operation of a magnetically operated part shall have a minimum wall thickness as specified in Table 9.1 unless:

a) The thinner component is shielded from any electrical component that is subject to arcing by an insulation barrier at least 0.028 inch (0.71 mm) thick or a grounded metal barrier of such construction that an arcing fault between the electrical component and the barrier will prevent the arc from reaching the thinner section of the enclosure, or other equivalent means. Overcurrent protection, when provided in the circuit, shall be evaluated. An insulating material barrier, when provided, shall be evaluated with respect to moisture absorptive properties, combustibility, resistance to distortion at temperatures to which it will be subjected, and thermal aging in accordance with UL 746C;

b) Internal wiring is secured or mounted such that it does not contact the thinner component;

c) Mechanical protection is provided, such as by location within the equipment, to reduce the risk of mechanical damage to the thinner component, except for a component such as a flexure tube where such protection is unable to be obtained; and

d) The thinner component is formed of stainless steel, brass, or other corrosion-resistant metal which complies with these requirements.

9.4 The minimum thickness of an enclosure shall be as specified in Table 9.1 unless:

a) The construction is such that the enclosure is protected against arcing as described in 9.3 (a) and (b); or

b) The available energy of circuits inside the enclosure is limited, such as a Class 2 or Class 3 circuit, so that any arcing that occurs within the enclosure does not cause burnthrough of the enclosure or raise the temperature of the enclosure at any point to a temperature in excess of the minimum ignition temperature for any material in any of the hazardous location groups for which the equipment is being investigated; or

c) A combination of (a) and (b).

Exception No. 1: The minimum thickness requirements of Table 9.1 do not apply when the thickness is at least:

a) 0.093 inch (2.36 mm) for cast brass, bronze, copper, or malleable iron;

b) 0.125 inch (3.18 mm) for cast iron or aluminum; or

c) 0.067 inch (1.70 mm) for sheet steel.

Exception No. 2: The minimum thickness requirements of Table 9.1 do not apply when the thinner enclosure wall or walls are protected against mechanical damage by:

a) The construction of the device; or

b) Installation of the device when installed as intended.

10 Joints in Enclosures

10.1 General

10.1.1 Joints in an enclosure shall comply with the applicable requirements in 10.1.2 – 10.6.3.1, and Section 21, Explosion Tests.

Exception: This requirement does not apply to joints that comply with the requirements in Annex A, Alternative Joints in Enclosures, and Annex B, Alternative Explosion Tests.

10.1.2 A joint in an enclosure shall be of the metal-to-metal, metal-to-glass, metal-to-polymeric, polymeric-to-polymeric, or polymeric-to-glass type. The joint surface shall have an arithmetical average roughness of not more than 250 microinches (0.0064 mm), in accordance with ASME B46.1.

10.1.3 A joint shall be continuous and without interruption by an O-ring groove or the like.

10.2 Cemented joints

10.2.1 When a part that is not intended to be removed after assembly, and that is not required to be opened to install or service the equipment is cemented with a cemented compound, the compound shall comply with the following as applicable:

a) Epoxy and RTV silicone rubber shall resist solvent action in compliance with Section 34, Chemical Resistance Tests on Sealing and Cementing Compounds;

b) RTV silicone rubber shall resist aging in accordance with the air-oven aging test method found in 41.3;

c) Plaster-based cements shall resist moisture in compliance with Section 89, High Humidity Tests; and

d) Comply with the requirements of 25.2, without loosening or cracking, or showing other signs of deterioration.

10.2.2 The length of the compound seal shall be either the minimum length of joint required for an unsealed joint, or 5/8 inch (15.9 mm), whichever is less.

10.2.3 The seal shall contain no voids between the mating parts forming the joint.

10.2.4 The sealing compound shall not be relied upon for mechanical security of the joint.

10.3 Joints with flamepaths Class I, Groups A, B, C, and D

10.3.1 A sealing material applied to a joint surface in accordance with Exception No. 1 to 16.4 shall not increase the maximum clearance between joint surfaces beyond the dimensions specified in this Standard.

10.3.2 A polymeric-to-polymeric joint shall be of the labyrinth or threaded type, and shall comply with the requirements in Section 33, Non-Metallic Enclosure Materials Tests.

10.3.3 The free-internal volume is determined to be the total internal volume of an electrical enclosure minus the volume of internal components. The volume of potting compounds is not used in the determination of the free-internal volume.

Exception No. 1: Potting compounds used for factory-installed lead wire seals, coil encapsulation, or coil insulation are to be used in the determination of the free-internal volume.

Exception No. 2: Potting compounds are to be used in determining the free-internal volume when the compounds:

a) Have been investigated to determine that they will withstand exposure to the flammable vapors involved in that they will remain in place inside the enclosure; and

b) Are free of voids.

10.3.4 A feeler gauge utilized to measure the clearances specified in these requirements is to be 1/8 to 1/2 inch (3.2 to 12.7 mm) wide, with a 1/2-inch-wide gauge preferred. The width of the joint is to be measured with the parts forming the joint assembled in the most unfavorable position.

10.3.5 A gasket shall not be employed in a metal-to-metal, metal-to-polymeric, or polymeric-to-polymeric joint. A gasket that is adjacent to a joint and does not increase the clearance, nor decrease the length of the joint specified in this Standard for the Group and type of joint, meets the intent of this requirement.

10.3.6 A gasket functioning as an active member in the flamepath is not prohibited from being employed in a metal-to-glass, polymeric-to-metal or polymeric-to-glass joint when the gasket complies with the requirements in 10.3.7 – 10.3.10. The maximum clearance between the gasket and the metal, polymeric, or glass shall not be more than that specified in this Standard for the Group and type of joint.

10.3.7 The use of a gasket functioning as an active member in the flamepath shall be limited to a joint that is not disturbed during the installation or intended servicing of the equipment.

10.3.8 A gasket functioning as an active member in the flamepath shall be a metal-covered type, formed from polytetrafluoroethylene, or other material that has been investigated and found capable of being used for the application. See 27.1. A metal-covered gasket in a metal-to-glass or polymeric-to-glass joint shall be mechanically attached to the glass. There shall be no overlapping of the metal covering the gasket on the joint surfaces.

10.3.9 When a gasket of polytetrafluoroethylene or similar material is used, it shall be installed in such a manner as to reduce the occurrence of cold flow of the gasket material.

10.3.10 A material that upon aging readily hardens or adheres to a joint surface, or both, is not to be used as a gasket material. A gasket, functioning as an active member in the flamepath, which is attached by an adhesive or a cement does not comply with this Standard.

10.3.11 A joint of the labyrinth type shall comply with the requirements in 21.26.

10.3.12 A labyrinth joint shall consist of not less than 3 adjacent segments where the path changes direction not less than 2 times.

10.4 Class I, Groups C and D locations

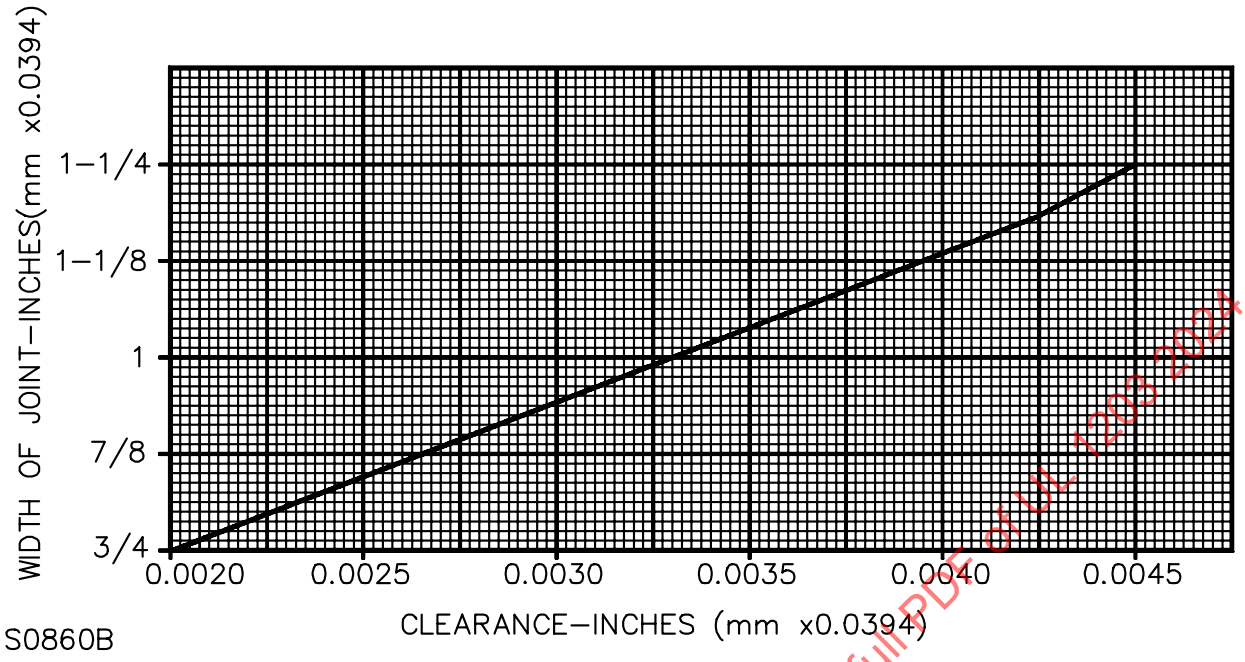
10.4.1 General

10.4.1.1 Except as indicated in 10.4.1.2 – 10.4.1.5 and 10.4.2.1, the width of a joint and the clearance, when assembled, shall be as specified in Figure 10.1. The width of the joint shall not be less than 3/4 inch (19.1 mm).

10.4.1.2 A rabbet joint is not prohibited from having a diametrical clearance at the axial section of not more than twice the clearance specified in 10.1 when neither the axial nor the radial section of the joint is less than 1/16 inch (1.6 mm) wide.

Figure 10.1

Relation Between Clearance and Width of Joint



10.4.1.3 An enclosure having a free-internal volume of not more than 300 cubic inches (4.92 dm^3) is not prohibited from having a 1/2 inch (12.7 mm) wide rabbet joint or a 3/8 inch (9.5 mm) wide flat joint when details comply with (a) or (b), respectively.

a) One-half-inch-wide rabbet joint (see Figure 10.2).

1) Neither the axial nor the radial section of the joint is less than 3/64 inch (1.2 mm) wide;

2) The diametrical clearance of the axial section and the clearance of the radial section is not more than 0.002 inch (0.05 mm); and

3) The joint width measured from the inside of the enclosure to the nearest edge of each bolt clearance hole and elsewhere is not less than 1/2 inch (12.7 mm).

b) Three-eighths-inch-wide flat joint (see Figure 10.3).

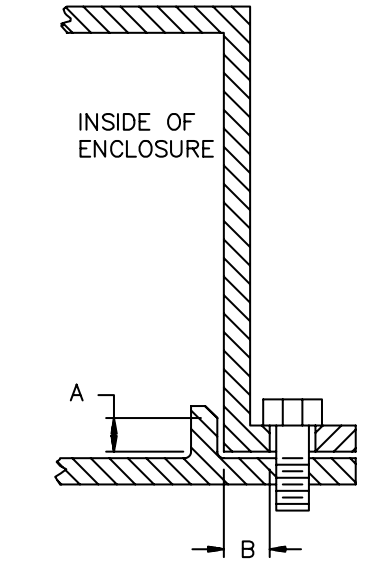
1) The clearance between the joint surfaces is less than 0.0015 inch (0.038 mm) or such that a 0.0015-inch feeler gauge will not enter the joint more than 1/8 inch (3.2 mm) at any point;

2) The thickness of the cover at the joint width is not less than 3/8 inch (9.5 mm), unless stiffened or reinforced material less thick has been found to be capable of being used when judged with respect to opening of joint clearance under internal pressures; and

3) The joint width measured from the inside of the enclosure to the nearest edge of each bolt clearance hole is not less than 3/8 inch (9.5 mm).

Figure 10.2

Rabbet Joint

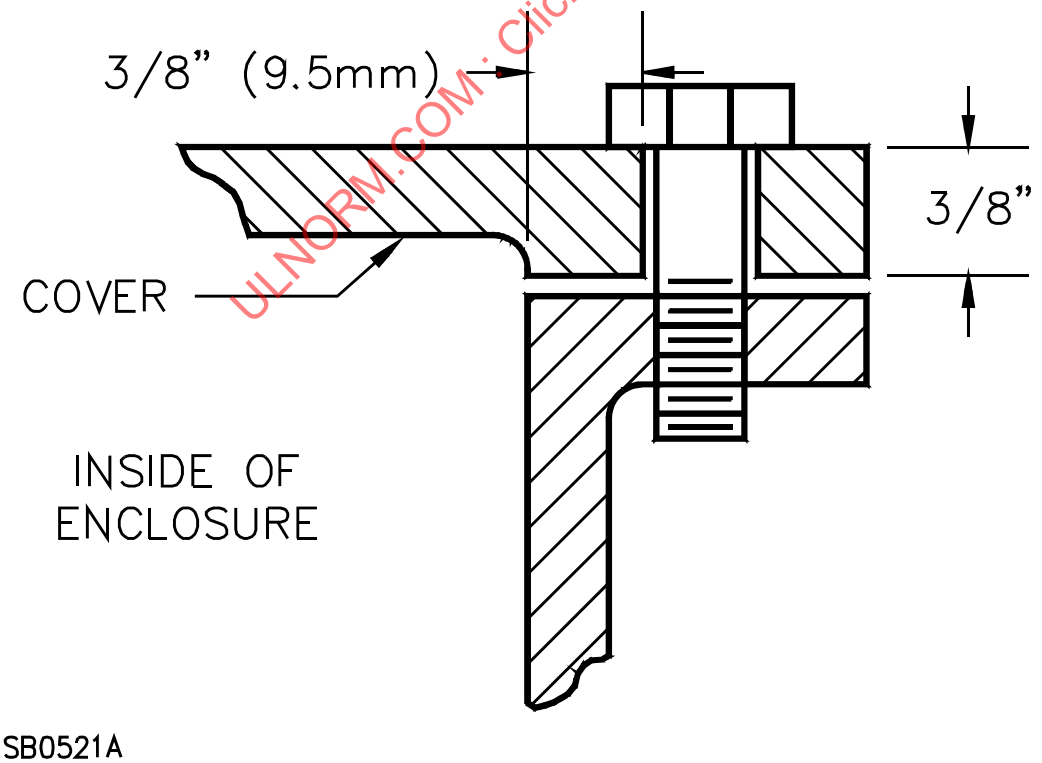


A + B = 1/2 inch (12.7 mm) for Class I, Groups C and D enclosures having free internal volume not more than 300 cubic inches (4.92 dm^3)

A + B = 7/8 inch (22.2 mm) for Class I, Group B enclosures having free internal volume not more than 100 cubic inches (1.64 dm^3)

Figure 10.3

3/8-inch (9.5-mm) Wide Flat Joint



10.4.1.4 The width of a joint in an enclosure having a free internal volume of not more than 6 cubic inches (0.1 dm^3) shall not be less than 1/4 inch (6.4 mm). For an enclosure for Group C locations, the clearance between the joint surfaces shall not be more than 0.004 inch (0.10 mm). For an enclosure for Group D locations, the clearance between the joint surfaces shall not be more than 0.006 inch (0.15 mm).

10.4.1.5 An enclosure shall be permitted to contain a venting section for the purpose of relieving internal explosion pressures. When the maximum explosion pressure developed during the explosion tests does not exceed 5 psig (34.5 kPa), a joint in a vented enclosure shall be permitted to have a width of not less than 1/4 inch (6.4 mm), and a clearance of not more than 0.005 inch (0.13 mm). A venting section shall afford protection against propagation of flame.

10.4.1.6 A 3/4 inch (19.1 mm) or wider joint shall not have an interruption, such as a groove for an O-ring, unless:

a) The interruption has a maximum cross-sectional area of 0.05 $inch^2$ (32.3 mm^2);

b) The joint width from the inside of the enclosure to the inner edge of the interruption is more than 1/2 inch (12.7 mm); and

c) The balance of the required minimum joint width is provided from the outer edge of the interruption, to the outside of the enclosure.

10.4.2 Labyrinth joints, Groups A, B, C, and D

10.4.2.1 A joint of the labyrinth type shall comply with the requirements in 21.26.

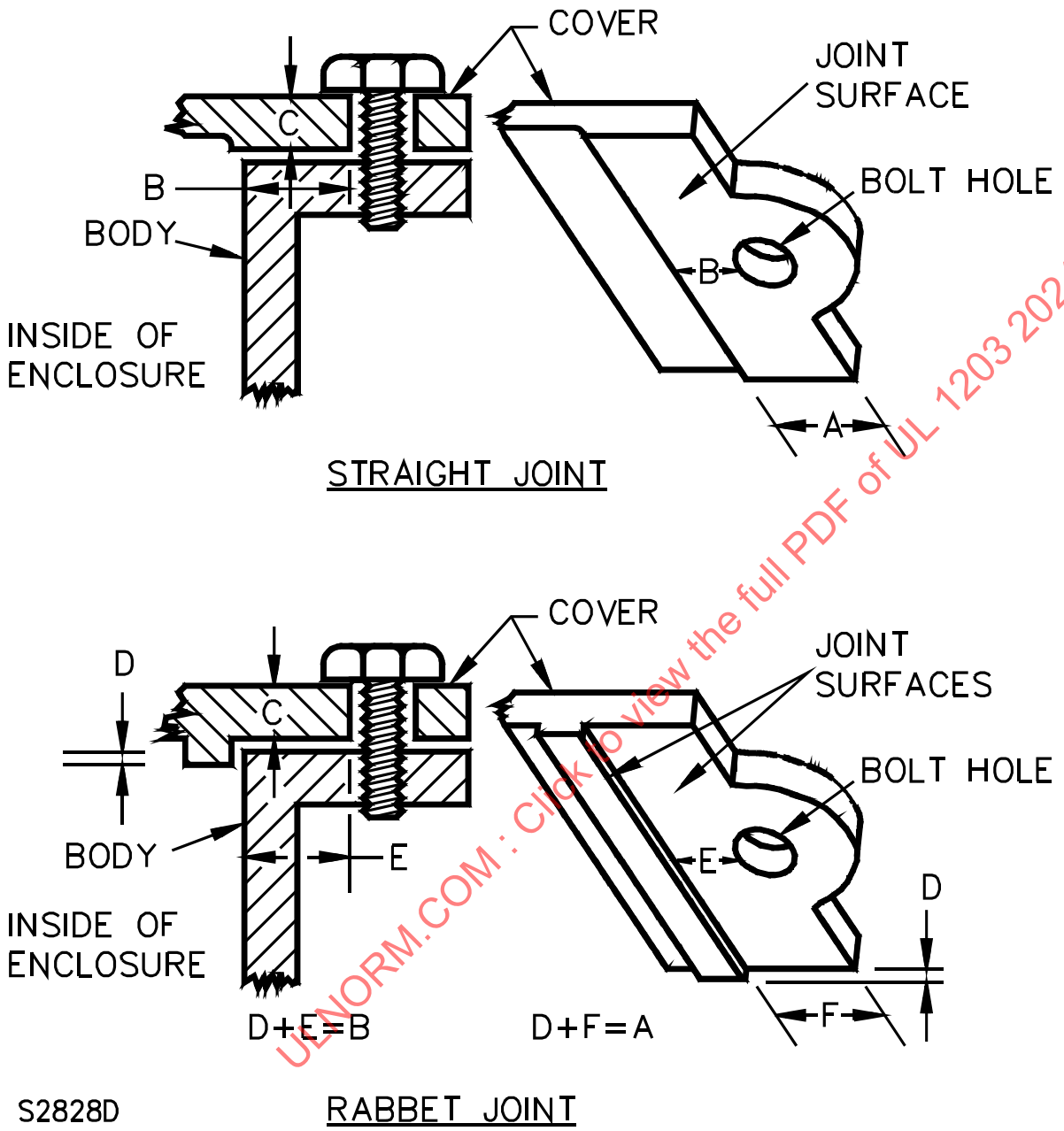
10.4.2.2 A labyrinth joint shall consist of not less than 3 adjacent segments where the path changes direction not less than 2 times.

10.4.3 Bolts in joint width

10.4.3.1 A bolt shall be permitted to be located in a 3/4 inch (19.1 mm) or wider joint when the distance from the inside of the enclosure to the nearest edge of the clearance hole for the bolt is not less than 1/2 inch (12.7 mm), and the diametrical clearance between the bolt and the clearance hole is not more than 0.045 inch (1.14 mm), measured over the shank or the major diameter of the threads, for a length of not less than one-half the required width of joint specified in Figure 10.1. The distance from inside the enclosure to the edge of the nearest clearance hole is measured with the cover in the most unfavorable position. See 10.4.3.4 and Figure 10.4.

Figure 10.4

Bolts in Joint Width



A = Required minimum width of joint (see Figure 10.1)

B = Minimum distance from inside enclosure to bolt clearance hole

C = One-half of required minimum width of joint

D = One part of rabbet joint

E = Second part of rabbet joint to bolt clearance hole

F = Second part of rabbet joint elsewhere

10.4.3.2 All bolt holes in a joint width shall be bottomed or the bolts or screws for fastening a cover shall each engage at least five full threads in a tapped hole.

10.4.3.3 A bolt in a joint width is not prohibited from being provided with a lock washer.

10.4.3.4 The requirements in 10.4.3.1 and 10.4.3.2 apply, in general, to machine screws having a round cross section. Screws that form their own machine-type thread and have been investigated for securing enclosure parts are not prohibited from being located in the joint width when they comply with the requirements in 10.4.3.1 and 10.4.3.2, except for measurement of the bolt clearance. In determining the clearance between a thread-forming screw and its clearance hole, the bolt dimension to be used is the minimum dimension of the cross section over the threads.

10.4.4 Cylindrical joints Groups A, B, C, and D

10.4.4.1 A flamepath having a cylindrical cross-section shall have a length of not less than 1 inch (25.4 mm). The diametrical clearance (difference in diameters) shall not be greater than 0.0033 inch (0.083 mm). The diametrical clearance of a path longer than 1-1/4 inch (31.8 mm) shall not be greater than 0.0045 inch (0.114 mm). For flamepath lengths greater than 1 inch (25.4 mm) but less than 1-1/4 inch (31.8 mm) the clearance shall be as given in Figure 10.1.

10.5 Class I, Group B locations

10.5.1 General

10.5.1.1 The width of a joint in an enclosure having a free internal volume of not more than 30 cubic inches (0.5 dm^3) shall not be less than 3/8 inch (9.5 mm). At a bolt hole, the width shall be measured from the inside edge to the nearest edge of the bolt clearance hole. The cover thickness at the joint flange shall not be less than 3/8 inch. The clearance between the joint surfaces shall be less than 0.0015 inch (0.038 mm) or such that a 0.0015 inch feeler gauge will not enter the joint more than 1/8 inch (3.2 mm) at any point. See Figure 10.3.

10.5.1.2 The width of a joint in an enclosure having a free internal volume of not more than 6 cubic inches (0.1 dm^3) shall not be less than 5/16 inch (7.9 mm) with a clearance between joint surfaces of not more than 0.002 inch (0.05 mm) or 3/8 inch (9.5 mm) with a clearance between joint surfaces of not more than 0.004 inch (0.10 mm). The cover thickness at the joint flange is not prohibited from being less than 3/8 inch.

10.5.2 The width of a joint in an enclosure having a free internal volume of more than 30 cubic inches (0.5 dm^3) and not more than 100 cubic inches (1.6 dm^3) shall not be less than 5/8 inch (15.9 mm). At a bolt hole, the width is to be measured from the inside edge to the nearest edge of the bolt clearance hole. The clearance between the joint surfaces shall be less than 0.0015 inch (0.038 mm) or such that a 0.0015-inch feeler gauge will not enter the joint more than 1/8 inch (3.2 mm) at any point. A rabbet joint shall have a total width of not less than 7/8 inch (22.2 mm), with neither section of joint being less than 3/8 inch (9.5 mm) wide. The diametrical clearance at the axial section of joint shall not be more than 0.0025 inch (0.064 mm), and the clearance at the radial or clamped section of joint shall not be more than 0.0015 inch. See Figure 10.2.

10.5.3 The width of a joint in an enclosure having a free internal volume of more than 100 cubic inches (1.64 dm^3) and not more than 350 cubic inches (5.7 dm^3) shall not be less than 1 inch (25.4 mm). At a bolt hole, the width shall be measured from the inside edge to the nearest edge of the bolt clearance hole. The clearance between the joint surfaces shall not be more than 0.0015 inch (0.038 mm).

10.5.4 Bolts in joint width

10.5.4.1 A bolt shall be permitted to be located in the joint width of an enclosure having a free internal volume (air volume) of more than 100 and not more than 350 cubic inches (1.6 – 5.7 dm^3) when it complies with the requirements in 10.5.4.2 and 10.5.4.3.

10.5.4.2 A bolt is not prohibited from being located in a 1 inch (25.4 mm) or wider joint when the distance from the inside of the enclosure to the nearest edge of the clearance hole for the bolt is not less than 55/64 inch (21.8 mm), and the diametrical clearance between the bolt and the clearance hole is not more than 0.045 inch (1.14 mm), measured over the shank or the major diameter of the threads, for a length of not less than one-half the required width of joint. The distance from inside the enclosure to the edge of the nearest clearance hole is measured with the cover in the most unfavorable position. See 10.5.4.5 and Figure 10.4.

10.5.4.3 All bolt holes in a joint width shall be bottomed or the bolts or screws for fastening a cover shall each engage at least five full threads in a tapped hole.

10.5.4.4 A bolt in a joint width is not prohibited from being provided with a lock washer.

10.5.4.5 The requirements in 10.5.4.1 – 10.5.4.3 apply, in general, to machine screws having a round cross section. Screws that form their own machine-type thread and have been investigated for securing enclosure parts are not prohibited from being located in the joint width when they comply with the requirements in 10.5.4.1 – 10.5.4.3, except for measurement of the bolt clearance. In determining the clearance between a thread forming screw and its clearance hole, the bolt dimension to be used is the minimum dimension of the cross section over the threads.

10.6 Threaded joints

10.6.1 Class I, Groups A, B, C, and D

10.6.1.1 The thread pitch in threaded joints shall not be finer than 32 threads per inch (0.79 mm pitch).

10.6.1.2 A joint of the serrated type with thread contour shall not have more than 20 serrations per inch (1.27 mm pitch) and shall have not less than 5 fully engaged and tightly clamped serrations.

10.6.1.3 All unused threaded openings through the walls of an explosionproof enclosure shall be closed by a device or a threaded plug. The joint formed, upon assembly, shall comply with 10.6.2.1.

10.6.1.4 For joints formed by a screw in a through hole securing a part, the screw shall be secured against removal by a lock nut, a lock washer, peening, staking, welding, or other mechanical means.

10.6.1.5 A thread locking compound shall be subjected to a special investigation.

10.6.1.6 Tapered threaded joints shall comply with Table 10.1.

Table 10.1
Tapered Threaded Joints

Pitch	≥ 0.9 mm
Threads provided on each part	≥ 5[b]
Threads engaged	c
On male threaded fittings with a shoulder or interruption, a thread length not less than the L4 dimension defined by ASME B1.20.1 shall be provided between the face of the shoulder and the end of the fitting thread.	
[a] Internal and external thread shall have the same nominal size, cone angle and thread form. [b] Threads shall conform to NPT requirements of ASME B1.20.1, and shall be made up wrench tight. [c] Adjustment of gauging practices is required to achieve the required engagement of threads. See Section 14, Supply Connections.	
Note: Gauging of female threads in IEC 60079-1 is flush to plus 2 turns of the plug gauge.	

10.6.2 Class I, Groups A and B

10.6.2.1 A threaded joint shall comply with the following:

a) For standard tapered pipe threads, not less than 5 fully engaged threads shall be provided; or

b) For parallel threads not finer than 20 threads per inch (1.27 mm pitch) the minimum number of threads required shall be not less than specified in Table 10.2 for the class of fit; or

c) For parallel threads not finer than 32 threads per inch (0.79 mm pitch) and tested as described in Section 21, Explosion Tests, the minimum number of threads required shall be not less than specified in Table 10.3.

Table 10.2
Minimum Threaded Engagement

Class of fit / minimum tolerance class		Minimum number of fully engaged threads
ANSI[a]	ISO[b]	
3	–	6
2	–	7
1	–	8
–	(6g/6H)	5
[a] See ASME B1.1. [b] See ISO 965-1 and ISO 965-3.		

Table 10.3
Threads Required Based Upon Enclosure Volume

Free internal volume of enclosure	Minimum number of fully engaged threads	Minimum length of thread engagement
≤ 6.1 inch^3 (≤ 100 cm^3)	5	0.25 inch (6 mm)
> 6.1 inch^3 (> 100 cm^3)	6	0.3125 inch (8 mm)

10.6.3 Class I, Groups C, and D

10.6.3.1 A threaded joint shall be made up with the number of fully engaged threads specified in Table 10.4. Threads shall not be finer than specified in Table 10.4.

Table 10.4
Thread Engagement

Maximum diameter of threaded sections, inch (mm)	Maximum number of threads per inch (per 25.4 mm)	Minimum number of threads engaged
No limit	20	5
3/8 (9.5)	24	5
Over 3/8	24	6
Over 3/8	28	7
Over 3/8	32	8

11 Shaft Openings

11.1 General

11.1.1 Shaft openings in an enclosure shall comply with the applicable requirements in 11.1.2 – 11.3.5.2 and Section 21, Explosion Tests.

Exception: This requirement does not apply to joints that comply with the requirements in Annex A, Alternative Joints in Enclosures and Annex B, Alternative Explosion Tests.

11.1.2 A shaft opening in an enclosure shall be of the metal-to-metal, metal-to-polymeric, or polymeric-to-ceramic type. See 10.1.2 regarding the roughness of the surfaces forming the shaft path joints.

11.1.3 The requirements in 11.2.1 – 11.3.5.2 apply to shaft openings in electrical enclosures for Class I, Groups C and D locations.

11.1.4 Equipment for Class I, Group A or B locations having a free internal volume of 30 cubic inches (0.5 dm^3) or less and a shaft that rotates at less than 100 rpm shall comply with the requirements in 11.2.1.

11.1.5 A shaft path shall be continuous and without interruption by an O-ring groove or the like.

11.2 Non-rotating shafts and shafts rotating at a speed of less than 100 rpm

11.2.1 A shaft opening in an enclosure shall have a length of path of not less than 1 inch (25.4 mm). The diametrical clearance (difference in diameter of the shaft and the opening in the enclosure) shall be as specified in Figure 10.1. The diametrical clearance of a path longer than 1-1/4 inch (31.8 mm) shall not be more than 0.0045 inch (0.114 mm). See 11.2.2.

Exception: An opening for a shaft that is centered in the opening by bearings or an equivalent construction that prevents contact between the shaft and the shaft opening is not required to comply with the requirements in 11.2.1 and 11.2.2 when it complies with the requirements in 11.3.1.3 – 11.3.5.2.

11.2.2 A shaft opening in an enclosure having non-rotating shafts and shafts rotating at a speed of less than 100 rpm and a venting section is not prohibited from having a diametrical clearance of 0.005 inch

(0.13 mm) for a maximum length of 1/2 inch (12.7 mm) when the explosion pressure developed in the explosion tests does not exceed 5 psi (34.5 kPa).

11.2.3 A device having a free internal volume of 1.0 cubic inch (0.016 dm^3) or less may have a length of path of not less than 9/32 inch (7.1 mm) with a diametrical clearance of not more than 0.005 inch (0.127 mm).

11.2.4 A device having a free internal volume of 6.1 cubic inches (100 cm^3) or less and tested as specified in 21.33 may have a shaft opening with a length and diametrical clearance as follows:

Minimum length of path inch (mm)	Maximum diametrical clearance inch (mm)
0.24 (6.0)	0.004 (0.10)
0.49 (12.5)	0.006 (0.15)

11.3 Shafts rotating at a speed of 100 rpm or more

11.3.1 General

11.3.1.1 Other than as noted in 11.3.1.2, the path at the opening for a shaft that rotates at a speed of 100 rpm or more shall comply with the requirements in 11.3.1.3 – 11.3.1.4.

11.3.1.2 For products, such as telemetering equipment, having a shaft that does not transmit power, is not intended to bear a load, and is intended to rotate at 100 rpm or more, the path at the shaft opening is not prohibited from complying with the requirements in 11.2.1 and 11.2.2.

11.3.1.3 The paths at shaft openings specified in 11.3.1.4 – 11.3.3.4 and 11.3.4.1 – 11.3.5.2 shall be in addition to any protection offered by the ball bearings or the sleeve bearings on the shaft.

11.3.1.4 The length of a shaft opening or path shall be determined by measuring only the metal-to-metal path. Oil or grease grooves without any inlet or outlet openings comply with the intent of this requirement when their size does not affect the protective value of the total length of path. Such grooves are not to be used in measuring the effective metal path. A labyrinth, when of a substantial form of construction, is evaluated as equivalent in length to a straight metal path. Openings for oil or grease shall be located outside the path.

11.3.1.5 A device having a free internal volume of 1.0 cubic inch (0.016 dm^3) or less may have a length of path of not less than 9/32 inch (7.1 mm) with a diametrical clearance of not more than 0.005 inch (0.127 mm).

11.3.1.6 A device having a free internal volume of 6.1 cubic inches (100 cm^3) or less and tested as specified in 21.33 may have a shaft opening with a length and diametrical clearance as follows:

Minimum length of path inch (mm)	Maximum diametrical clearance inch (mm)
0.24 (6.0)	0.004 (0.10)
0.49 (12.5)	0.006 (0.15)

11.3.2 Free internal volume of enclosure 65 cubic inches (1.1 dm^3) or less

11.3.2.1 An enclosure for Class I, Group D locations having a free internal volume of 65 cubic inches (1.1 dm^3) or less shall have a shaft opening with a length of not less than 1/4 inch (6.4 mm) and a diametrical clearance between shaft and shaft opening of not more than 0.015 inch (0.38 mm).

11.3.3 Free internal volume of enclosure 350 cubic inches (5.7 dm^3) or less

11.3.3.1 Except as indicated in 11.3.3.3 and 11.3.3.4, an enclosure for Class I, Group D locations having a free internal volume more than 65 cubic inches (1.1 dm^3) and not more than 350 cubic inches (5.7 dm^3), and a length (circumference) of joint not more than 32 inches (813 mm), shall have a shaft opening with a length of not less than 1-1/2 inches (38.1 mm) and a diametrical clearance of not more than 0.025 inch (0.64 mm).

11.3.3.2 A shaft opening in an enclosure for Class I, Group C locations shall:

a) Comply with the requirements in 11.3.3.1; and

b) Be provided with a labyrinth flame path of at least 1/8 inch (3.2 mm), the offset being not less than 1/16 inch (1.6 mm) (difference in diameters at least 1/8 inch) through two 90° turns.

11.3.3.3 A larger clearance at a shaft opening is not prohibited when there is an increase in length of metal path of 1/4 inch (6.4 mm) per 0.002 inch (0.05 mm) increase in diametrical clearance.

11.3.3.4 A proportional decrease in length of 1/4 inch (6.4 mm) per 0.002 inch (0.05 mm) decrease in diametrical clearance is not prohibited when the metal path is not less than 1 inch (25.4 mm).

11.3.3.5 When the path specified in 11.3.3.1 – 11.3.3.4 is not provided in addition to the length of the sleeve bearing, the bearing shall have an overall length of not less than 1-1/4 inches (31.8 mm). The necessary oil openings and grooves are not prohibited from being provided in this 1-1/4 inch length of sleeve bearing, subject to tests. In addition, the flame path shall either be:

a) Around a radial shaft shoulder of not less than 1/8 inch (3.2 mm) with end play limited by means of spring washers, or the equivalent, to less than 0.002 inch (0.05 mm) for an enclosure for Class I, Group D locations; or

b) Through a labyrinth with an offset not less than 1/16 inch (1.6 mm) (difference in diameters at least 1/8 inch) through two 90° turns. The labyrinth shall have a diametrical clearance of not more than 0.020 inch (0.50 mm) through a length of not less than:

1) For an enclosure for Class I, Group D locations, 1/4 inch (6.4 mm); and

2) For an enclosure for Class I, Group C locations, 3/8 inch (9.5 mm).

11.3.4 Free internal volume of enclosure more than 350 cubic inches (5.7 dm^3) with internal length of joint of 90 inches (2.29 m) or less

11.3.4.1 An enclosure for Class I, Group D locations having a free internal volume more than 350 cubic inches (5.7 dm^3) and an internal length (circumference) of joint less than 90 inches (2.29 m) shall have a shaft path complying with Table 11.1.

Table 11.1
Length of Shaft Opening and Diametrical Clearance

Minimum length of shaft opening		Maximum diametrical clearance	
inches	(mm)	inch	(mm)
1-1/2	(38.1)	0.025	(0.64)
2-1/2	(63.5)	0.030	(0.76)

11.3.4.2 A shaft opening in an enclosure for Class I, Group C locations shall:

a) Comply with the requirements in 11.3.4.1; and

b) Be provided with a labyrinth path of at least 1/8 inch (3.2 mm), the offset being not less than 1/8 inch [difference in diameters at least 1/4 inch (6.4 mm)] through two 90° turns.

11.3.5 Internal length of joint more than 90 inches (2.29 m)

11.3.5.1 An enclosure having an internal length (circumference) of joint larger than 90 inches (2.29 m) shall have at least two sections of labyrinth shaft paths complying with the dimensions in Table 11.2.

Table 11.2
Length of Labyrinth Path and Diametrical Clearance

Total length of labyrinth path		Maximum diametrical clearance		No section less than	
inches	(mm)	inch	(mm)	inch	(mm)[a]
2	(50.8)	0.025	(0.64)	1/4	(6.4)
3	(76.2)	0.030	(0.76)	1	(25.4)

[a] The lengths of adjacent labyrinth path sections shall be on different diameters with an offset not less than 1/8 inch (3.2 mm) (difference in diameters at least 1/4 inch) through two 90° turns.

11.3.5.2 The minimum dimensions specified in Table 11.2 shall be provided with the shaft in any position permitted by the end play of the shaft. The two adjacent sections of the path shall not be more than 5/8 inch (15.9 mm) apart, at any position provided by end play.

12 Holes in Enclosures

12.1 Except as indicated in 12.4, a hole in an enclosure for securing a part:

a) Shall be bottomed and the thickness of the metal remaining shall comply with the minimum thickness requirements for the enclosure;

Exception: When the hole is closed with a screw, the enclosure shall have a minimum thickness of 0.0625 inch (1.59 mm) and withstand the Hydrostatic Pressure Test, Section 22.

b) Shall be closed by welding of the part in place; or

c) The screw securing the part shall engage at least five full threads and be secured against removal by a lock nut, a lock washer, welding, peening, or the equivalent. When a self-tapping screw is used, it shall have a minimum of five full threads engaged when seated. A screw shall not have more than 32 threads per inch (per 25.4 mm).