



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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1

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No Text on This Page

CONTENTS

INTRODUCTION

1 Scope 11

2 Components 11

3 Units of Measurement 11

4 Referenced Publications 12

5 Enclosure Types 13

6 Class I, Zone and Group Equivalency 13

 6.1 Class I, Zone 1, Group IIA 13

 6.2 Class I, Zone 1, Group IIB 13

 6.3 Class I, Zone 1, Group IIC 13

 6.4 Zone 20 and Zone 21 13

7 Glossary 13

PART I – EXPLOSIONPROOF EQUIPMENT

CONSTRUCTION

8 Enclosure Material 15

9 Enclosure Thickness 15

10 Joints in Enclosures 16

 10.1 General 16

 10.2 Cemented joints 17

 10.3 Joints with flamepaths Class I, Groups A, B, C, and D 17

 10.4 Class I, Groups C and D locations 18

 10.5 Class I, Group B locations 23

 10.6 Threaded joints 24

11 Shaft Openings 26

 11.1 General 26

 11.2 Non-rotating shafts and shafts rotating at a speed of less than 100 rpm 26

 11.3 Shafts rotating at a speed of 100 rpm or more 27

12 Holes in Enclosures 29

13 Drain and Breather Fittings in Enclosures 30

14 Supply Connections 30

 14.1 Fixed equipment conduit and cable entries 30

 14.2 Cord-connected portable equipment 35

15 Protection Against Corrosion 38

16 Materials Applied to Joint Surfaces 39

17 Devices Having Coated Threaded Joint Surfaces 40

18 Porosity in Enclosure Materials 40

19 Polymeric Enclosures 40

PERFORMANCE

20 Temperature Test 41

21 Explosion Tests 41

22 Hydrostatic Pressure Test 47

23 Dynamic Pressure Test 48

24 Leakage Test on Factory-Installed Conduit Seals 48

25 Tests for Glass Parts 49

 25.1 Thermal-shock test 49

25.2	Impact test	49
26	Secureness Test on Supply Connection Hubs	49
27	Tests on Joint Gaskets	49
28	Electrical-Resistance Test	50
28.1	Grounding-continuity of cord-connected equipment.....	50
28.2	Equipment having coated threaded joint surfaces or conduit openings	50
29	Accelerated Aging Test on Bushings	50
30	Strain-Relief Test	50
31	Rough-Usage Test	51
32	Drop Test.....	51
33	Non-Metallic Enclosure Materials Tests	51
33.1	General.....	51
33.2	Chemical compatibility by material samples	52
33.3	Chemical compatibility by complete end product tests	53
33.4	Test for accumulation of static electricity	54
34	Chemical Resistance Tests on Sealing and Cementing Compounds.....	55

PART II – DUST-IGNITIONPROOF EQUIPMENT

CONSTRUCTION

35	Enclosure	57
35.1	General.....	57
35.2	Material.....	57
35.3	Thickness	57
36	Joints in Enclosures.....	58
37	Shaft Openings	59
38	Holes in Enclosures.....	60
39	Drain and Breather Fittings in Enclosures.....	61
40	Supply Connections	61
40.1	Fixed equipment.....	61
40.2	Cord-connected portable equipment	63
41	Protection Against Corrosion.....	63
41.1	General.....	63
41.2	Physical properties	64
41.3	Accelerated air-oven aging test.....	64
41.4	Compression set.....	65
41.5	Identification.....	66
42	Materials Applied to Joint Surfaces	66

PERFORMANCE

43	Dust-Penetration Test	67
44	Temperature Test with Dust Blanket.....	68
45	Polymeric Enclosure Tests	69
46	Leakage Test on Factory-Installed Conduit Seals.....	69
47	Tests for Glass Parts.....	69
48	Secureness Test on Conduit Hubs	69
49	Tests on Joint Gaskets.....	70
50	Electrical-Resistance Test	70
51	Accelerated-Aging Test on Bushings.....	70
52	Strain-Relief Test.....	70
53	Rough-Usage Test.....	70
54	Drop Test.....	70
55	Diaphragm Endurance Test.....	70



Documents

Document Sharing Hub

56	Test for Secureness of Conduit Hubs	70
56.1	General.....	70
56.2	Pullout	71
56.3	Bending	71

PART III – MANUFACTURING AND PRODUCTION TESTS

57	Bonding Test on Cord-Connected Equipment	72
58	Hydrostatic Pressure Test	72

PART IV – MARKINGS AND INSTRUCTIONS

59	Details.....	72
60	Installation Instructions	76
60.1	General.....	76
60.2	Electronic medium for required instructions.....	76

PART V – INDUSTRIAL CONTROL EQUIPMENT

61	General	77
----	---------------	----

CONSTRUCTION

62	Holes in Enclosures.....	78
----	--------------------------	----

PERFORMANCE

63	No-Load Endurance Test	78
----	------------------------------	----

MARKINGS

64	Details.....	78
----	--------------	----

PART VI – SWITCHES

65	General	79
----	---------------	----

CONSTRUCTION

66	Enclosure Thickness	79
67	Mounting of Switch Mechanism	80
68	Spacings	80
69	Insulating Barrier or Liner	80

RATINGS

70	General	80
----	---------------	----

MARKING

71	Details.....	81
----	--------------	----

PART VII – CIRCUIT BREAKERS

72	General	82
----	---------------	----

CONSTRUCTION

73	General	82
74	Wiring Space	83

MARKINGS

75	Details	88
----	---------------	----

PART VIII – OUTLET BOXES AND FITTINGS

76	General	90
76.1	General	90
76.2	Blanking elements	90
77	Material Thickness	92
78	Supply Connections for Class I Locations	92
79	Supply Connections for Class II Locations	92
80	Fitting for Mineral Insulated Cable	93
81	Conduit Fittings for Sealing	93
82	Flexible Fittings	93
83	Mineral Insulated Cable Fittings	93
84	Cord Connectors for Mobile or Portable Equipment	93
84.1	General	93
84.2	Terminal enclosure	94
84.3	Insulating bases	94
84.4	Live parts	95
84.5	Grounding	95
84.6	Terminals	96
84.7	Leads	97
84.8	Spacings	97
84.9	Insulating barrier or liner	98
84.10	Seal	98
84.11	Packing gland	99
84.12	Cord clamp	99
84.13	Securement of threaded engagements	100
84.14	External metal parts	100

PERFORMANCE

85	Explosion Test	100
86	Hydrostatic Pressure Test	102
86.1	General	102
86.2	Torque test for blanking elements	103
86.3	Torque tests for thread adapters	104
87	Dust Penetration Test	104
88	Leakage of Sealing Fittings Test	104
89	High Humidity Tests	105
90	Leakage of Mineral Insulated Cable Fittings Test	105
91	Electrical Resistance Test	105
91.1	Flexible fittings	105
91.2	Boxes or fittings having coated threaded joint surfaces	106
92	Arcing Test	106
93	Bending Test	106

94 Vibration Test 107

95 Endurance Load at Elevated Temperature Test 108

96 Tension Test 108

97 Moist Ammonia-Air Stress Cracking Test 108

98 Accelerated Aging of Bushing Test 109

99 Cord Pull Test 109

100 Solvent and Water Condensate Exposure Test 109

101 Secureness of Conduit Hubs Test 110

102 Markings 110

PART IX – RECEPTACLE-PLUG COMBINATIONS

INTRODUCTION

103 General 115

CONSTRUCTION

104 General 115

105 Material 115

106 Live Parts 116

107 Grounding 116

108 Supply Connection 117

108.1 Receptacle 117

108.2 Plug 117

108.3 Plug and receptacle 117

109 Receptacle Employing Interlocking Switch or Circuit Breaker 119

110 Contact and Blade Exposure 120

111 Spacings 122

112 Assembly 123

PLUG

113 General 123

114 Enclosure 123

115 Strain Relief 124

116 Bushings 124

117 Enclosure – Material 124

118 Seal Between Electrical Enclosure and Receptacle Contacts 124

119 Bonding 125

PLUG AND RECEPTACLE FOR FLAMMABLE ANESTHETIZING LOCATIONS

120 General 125

PERFORMANCE

121 General 127

122 Overload Test 128

123 Normal Temperature Test 129

124 Strain-Relief Test 131

125 No-Load Endurance Test 131

126 Full-Load Endurance Test 131

127 Test for Arc-Sustaining in the Presence of Explosive Atmospheres 132

128 Overload Test in the Presence of Explosive Atmospheres 133

129 Test for Arcing in the Presence of Grain Dust-Air Atmospheres 133

130 Watertightness Test 133

MARKINGS

131 Details 134

PART X – ELECTRICALLY OPERATED VALVES

132 General 135

CONSTRUCTION

133 Enclosure Thickness..... 135

PERFORMANCE

134 General 135

135 Temperature Test 136

136 Burnout Test..... 137

MARKINGS

137 General 138

138 Installation Instructions 139

PART XI – TESTS ON POLYMERIC VALVE ENCLOSURES

139 General 139

140 Explosion Tests 139

141 Hydrostatic Pressure Test 139

142 Conduit Connection Tests 140

143 Impact Tests..... 140

144 Thermal Cycling Test 141

145 Thermal Shock Test..... 141

TESTS ON ENCLOSURES FOR CLASS II VALVES

146 General 141

147 Test for Accumulation of Static Electricity..... 142

148 Dust-Penetration Test 142

149 Connection Tests..... 142

150 Impact Tests..... 142

151 Thermal Cycling Test 142

152 Thermal Shock Test..... 143

ANNEX A (normative) – ALTERNATE JOINTS IN ENCLOSURES

A1 General..... 144

A2 Cemented Joints 144

A3 Joints with Flamepaths Class I, Groups A, B, C, and D..... 144

A4 Labyrinth Joints Groups A, B, C, and D..... 145

A5 Threaded Joints 145

 A5.1 General – Class I, Groups A, B, C, and D 145

A5.2 Class I, Groups A and B..... 145

A5.3 Class I, Groups C, and D 146

SA6 Joints with Flamepaths: Class I, Groups A, B, C, and D 146

ANNEX B (normative) – ALTERNATIVE EXPLOSION TESTS

B1 Explosion Tests..... 154

ANNEX C (normative) – CELLS AND BATTERIES

C1 General..... 160

C2 Temperature Limiting Devices..... 160

C3 Charging of Secondary Cells 160

C4 Discharging of Secondary Cells 161

C5 Battery Ventilation..... 161

C6 Tests..... 161

 C6.1 Battery operating temperature test..... 161

 C6.2 Charging circuit verification test..... 161

 C6.3 Discharging circuit verification test..... 161

C7 Marking and Instructions 161

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.

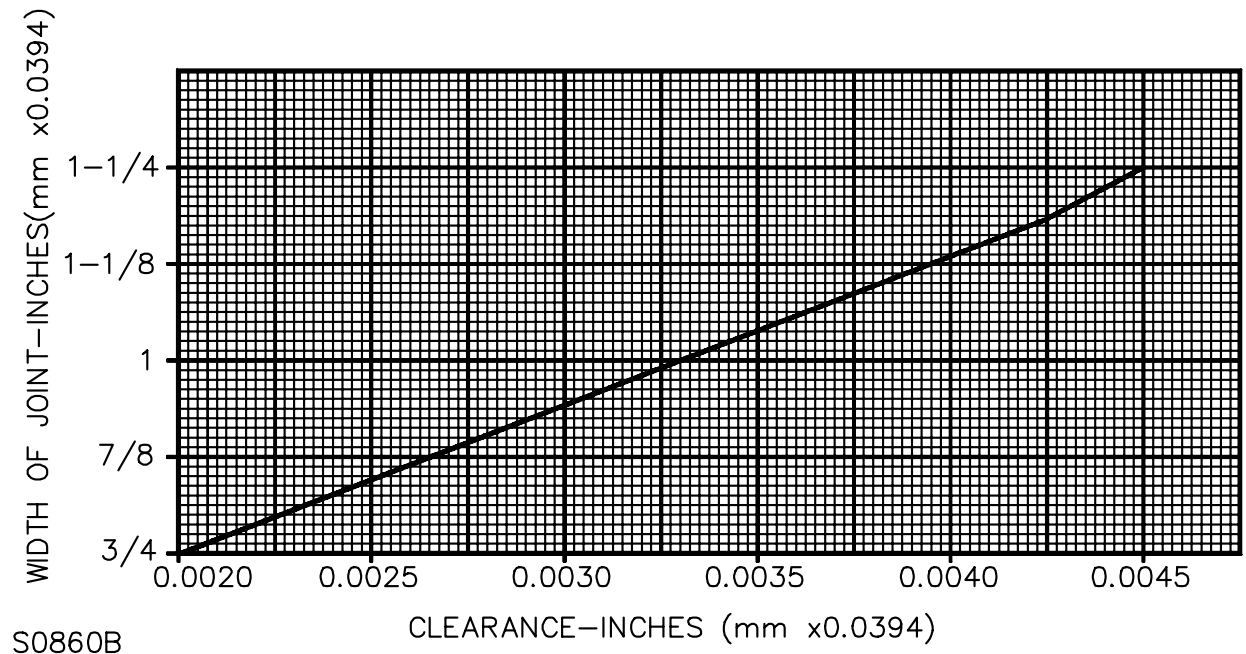
10.4 Class I, Groups C and D locations

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



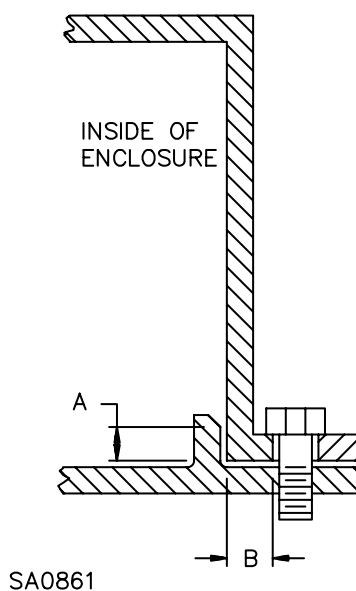
10.4.1.3 An enclosure having a free-internal volume of not more than 300 cubic inches (4.92 dm³) is not prohibited from having a 1/2 inch (12.7 mm) wide rabbet joint or a 3/8 inch (9.5 mm) wide flat joint when details comply with (a) or (b), respectively.

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).

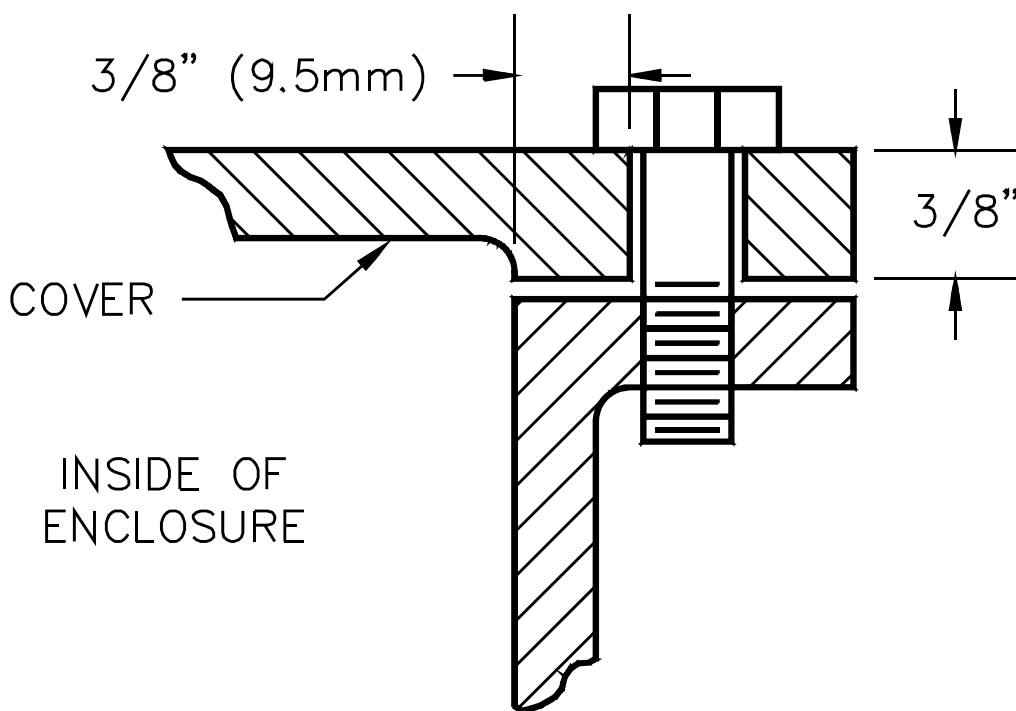
b) Three-eighths-inch-wide flat joint (see [Figure 10.3](#)).

- 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 dm³)

$A + B = 7/8$ inch (22.2 mm) for Class I, Group B enclosures having free internal volume not more than 100 cubic inches (1.64 dm³)

Figure 10.3**3/8-inch (9.5-mm) Wide Flat Joint**

SB0521A

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 dm³) 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 inch² (32.3 mm²);
- 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

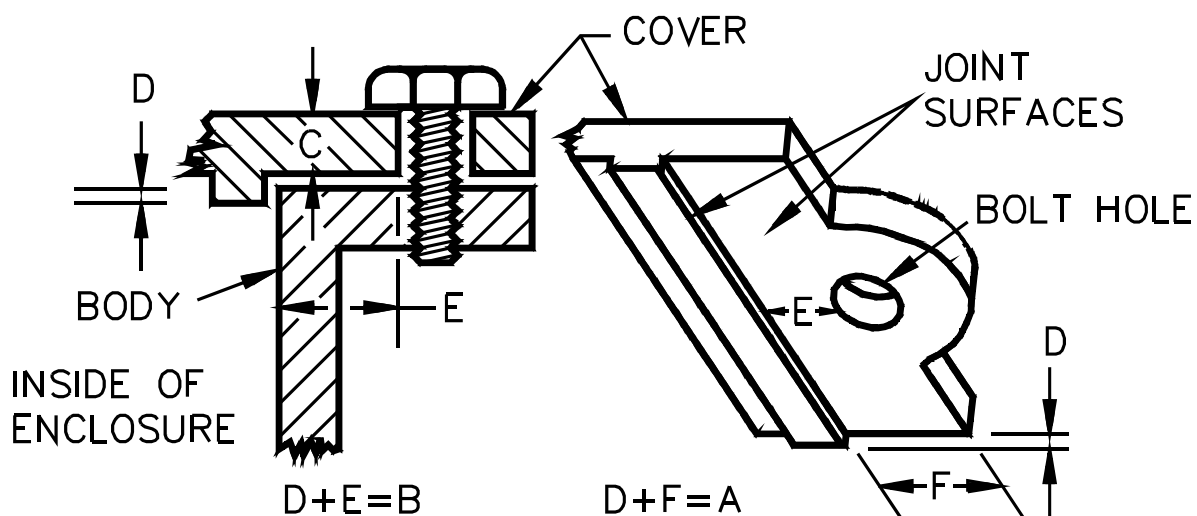
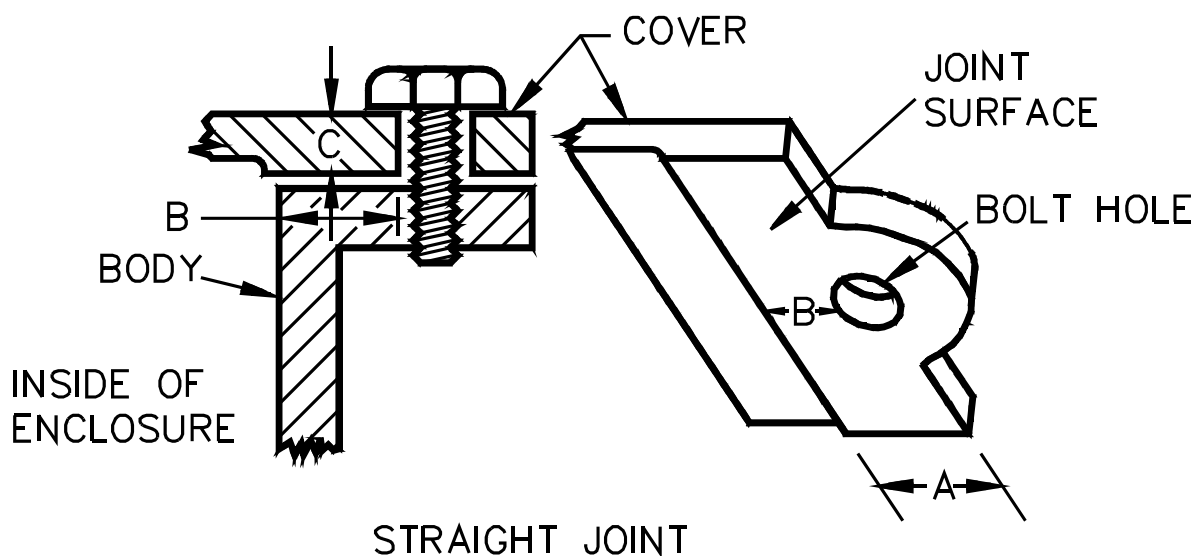
10.4.2.1 A joint of the labyrinth type shall comply with the requirements in [21.26](#).

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



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RABBET JOINT

- 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 flame path 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 flame path 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 dm³) 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 dm³) 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 dm³) and not more than 100 cubic inches (1.6 dm³) 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 dm³) and not more than 350 cubic inches (5.7 dm³) 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 dm³) 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 dm³) 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 dm³) 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 cm³) 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 dm³) 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 cm³) 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 dm³) 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 dm³) 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 dm³) 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 dm³) and not more than 350 cubic inches (5.7 dm³), 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 dm³) 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 dm³) 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).

12.2 A metal pin or a part press-fitted through the wall of an enclosure shall engage for at least 3/8 inch (9.5 mm). Such a part shall be secured against removal by welding, peening, or equivalent mechanical securement.

12.3 Unless an attachment complies with the requirements in [12.1](#) or [12.2](#), holes in an enclosure for attachment of a nameplate shall be bottomed. The remaining thickness at the bottomed hole shall withstand the Hydrostatic Pressure Test, Section [22](#), and shall not be less than 1/16 inch (1.6 mm).

12.4 A tapped hole shall not be provided in a sintered-metal part employed as a venting section of an enclosure.

12.5 An open-type receptacle complying with the requirements in [10.6](#) and threaded into the enclosure, or a closure plug threaded into an opening in the enclosure for such a receptacle need not be secured against removal.

12.6 An open-type receptacle shall close the opening into which it is installed in a manner that complies with the requirements in this standard when installed in accordance with the manufacturer's instructions.

13 Drain and Breather Fittings in Enclosures

13.1 Drain and breather fittings shall:

- a) Drain a liquid from the enclosure without removal of any part of the fitting;
- b) Be located to reduce the risk of damage to the fitting; and
- c) Be permanently attached to the enclosure unless trade size 1/2 or larger NPT threads are provided in accordance with [14.1.1.2](#).

13.2 The metal-to-metal joint between a drain fitting and the enclosure shall comply with the requirements specified for joints in the enclosure.

13.3 Drain and breather fittings supplied as a part of an explosionproof electrical enclosure shall comply with the requirements in Section [21](#), Explosion Tests and Section [22](#), Hydrostatic Pressure Test.

13.4 Drain and breather fittings intended to be installed in a supply connection opening in accordance with installation instructions for installation of the fitting shall comply with the requirements in Section [85](#), Explosion Test and Section [86](#), Hydrostatic Pressure Test.

14 Supply Connections

14.1 Fixed equipment conduit and cable entries

14.1.1 General

14.1.1.1 Equipment intended for permanent installation shall have provision for connection to threaded rigid metal conduit or other wiring methods in accordance with Article 501 in NFPA 70.

Exception: The equipment enclosure is not required to comply with this requirement when instructions are provided in accordance with [59.21](#).

14.1.1.2 NPT threaded entries shall be permitted and shall use a modified National Standard Pipe Taper (NPT) thread with thread form per ASME B1.20.1. Entries shall not be smaller than trade size 1/2 nor larger than trade size 6. Factory-threaded entries shall conform to ASME B1.20.1 except that entries shall

gauge from flush to plus 3-1/2 turns beyond the L-1 gauging notch in lieu of the minus 1 to plus 1 turns described in ASME B1.20.1. Supply connection threads shall comply with Section 21, Explosion Tests.

14.1.1.3 Each entry shall be provided with one of the following constructions:

- a) A smooth and well-rounded integral conduit stop, having a throat or inner diameter as specified in Table 14.1;
- b) A smooth and well-rounded inner end as shown in Figure 14.1; or
- c) Threads not exceeding the maximum number specified in Table 14.2 for the conduit size, such that a conduit bushing is able to be installed on the end of the conduit after it is engaged with the entry threads.

Exception: The opening is not required to comply with this requirement when instructions are provided in accordance with 59.19.

14.1.1.4 Where a conduit stop (also known as an integral bushing) is not provided, the inner end of the entry shall be smooth and well-rounded. The dimensions of a conduit stop, if provided, shall be as shown in Table 14.1.

Table 14.1
Throat Diameter of Conduit Stop

Trade size of conduit		Throat diameter of conduit stop, inches (mm)			
Inches	(mm OD)	Minimum		Maximum	
1/2	(21.3)	0.560	(14.22)	0.622	(15.80)
3/4	(26.7)	0.742	(18.85)	0.824	(20.93)
1	(33.4)	0.944	(23.98)	1.049	(26.64)
1-1/4	(42.2)	1.242	(31.55)	1.380	(35.05)
1-1/2	(48.3)	1.449	(36.80)	1.610	(40.89)
2	(60.3)	1.860	(47.24)	2.067	(52.50)
2-1/2	(73.0)	2.222	(56.44)	2.469	(62.71)
3	(88.9)	2.761	(70.13)	3.068	(77.93)
3-1/2	(101.6)	3.193	(81.10)	3.548	(90.12)
4	(114.3)	3.623	(92.02)	4.026	(102.26)
5	(141.3)	4.542	(115.37)	5.047	(128.19)
6	(168.3)	5.458	(138.63)	6.065	(154.05)

Figure 14.1
Conduit Opening Without Conduit Stop

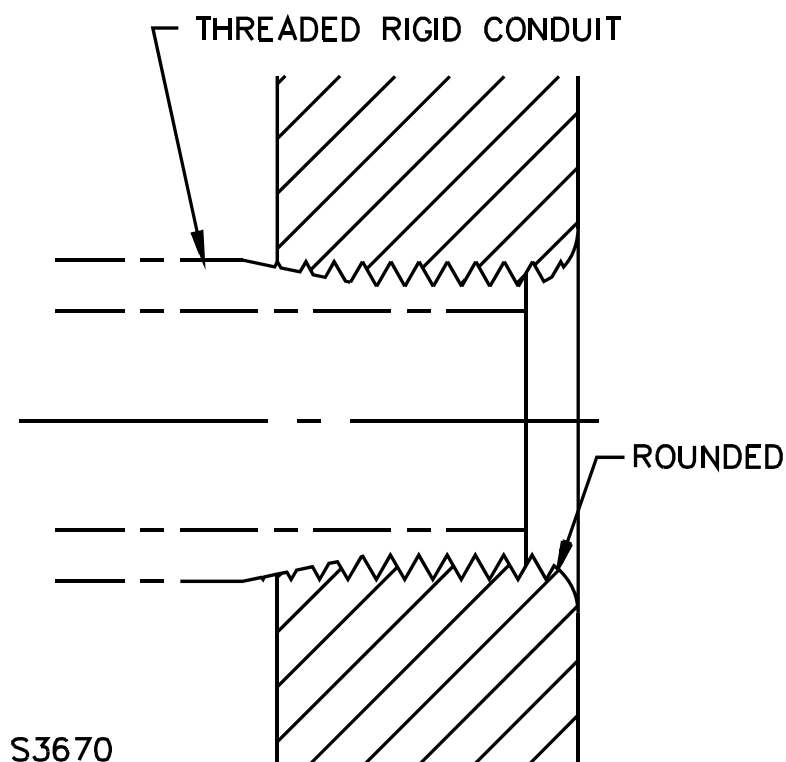


Table 14.2
Number of Threads in a Conduit Opening Without an Integral Stop

Trade size of conduit		Number of threads per inch (25.4 mm)	Maximum number of threads
inches	(mm OD)		
1/2	(21.3)	14	6
3/4	(26.7)	14	6
1	(33.4)	11-1/2	6
1-1/4	(42.2)	11-1/2	6
1-1/2	(48.3)	11-1/2	7
2	(60.3)	11-1/2	7
2-1/2	(73.0)	8	7
3	(88.9)	8	8
3-1/2	(101.6)	8	8
4	(114.3)	8	9
5	(141.3)	8	9
6	(168.3)	8	9

14.1.1.5 Metric threaded entries shall comply with the requirements in [10.6](#), Threaded Joints, and Section [21](#), Explosion Tests. Means shall be provided to minimize abrasion to conductor insulation.

14.1.1.6 Metric threaded entries shall have a permanent marking near the supply connection opening in accordance with [59.22](#).

Exception: Equipment which uses a thread type other than NPT or NPS is not required to have the marking in [59.22](#) when it is provided with an adapter to NPT or NPS thread form. The adapter shall comply with the applicable construction and performance requirements in Part VIII in this Standard.

14.1.1.7 When an integral conduit stop is provided, it shall be smooth and well-rounded, having a throat or inner diameter as specified in [Table 14.1](#).

14.1.1.8 When an integral conduit stop is provided in the conduit opening of an enclosure for Class I, Group A or B locations, the threads shall be tapered 3/4 inch per foot (62.5 mm/m).

14.1.1.9 NPS threaded entries may be provided for an enclosure for Group C or D locations and shall use a National Standard Pipe Straight (NPS) thread per ASME B1.20.1 and shall include an integral bushing and shall provide five full threads. The dimensions of the integral bushing shall be as shown in [Table 14.1](#).

14.1.1.10 When an integral conduit stop is not provided in a conduit opening, the threads shall be tapered 3/4 inch per foot (62.5 mm/m).

14.1.1.11 All openings for a power supply connection, except those required for installation, shall be furnished with metal close-up plugs engaging the opening in accordance with [10.6](#).

14.1.1.12 A supply connection hub not integrally cast with an enclosure shall:

- a) Have a wall thickness before threading not less than that of the corresponding trade-size conduit;
- b) Not depend upon friction alone to prevent it from turning; and
- c) Comply with the Secureness Test on Supply Connection Hubs, Section [26](#).

14.1.1.13 Enclosures capable of being drilled and tapped in the field with supply connections shall have wall sections which are capable of accommodating the trade size openings that are added in the field. These enclosures shall be provided with field drilling and tapping instructions in accordance with [59.21](#).

14.1.1.14 Male NPT threaded fittings having a shoulder or other interruption that can interfere with thread engagement shall have a threaded length not less than the L4 dimension shown in ASME B1.20.1 when measured from the end of the fitting thread to the face of a shoulder or to an interruption.

14.1.1.15 Male NPT threaded fittings shall gauge ± 1 turn of the ring gauge from being flush with the end of the thread in accordance with ASME B1.20.1.

14.1.1.16 A conduit hub not integrally cast with an enclosure shall:

- a) Have a wall thickness before threading of not less than that of the corresponding trade-size conduit,
- b) Not depend upon friction alone to prevent it from turning, and
- c) Comply with the Secureness Test on Supply Connection Hubs, Section [26](#).

14.1.2 Conduit seals

14.1.2.1 A factory-installed conduit seal incorporated as part of the equipment shall:

- a) Comply with the applicable requirements in [14.1.2.2](#), [14.1.2.3](#), and Section [24](#), Leakage Test on Factory-Installed Conduit Seals; and
- b) Be marked in accordance with [59.15](#).

14.1.2.2 When a conduit seal is incorporated, the wires or conductors shall be securely held and tightly sealed where they pass into the enclosure. When a sealing compound or cement is used, it shall:

- a) Provide a tight fit;
- b) Neither soften nor crack under service conditions;
- c) Be resistant to chemicals as required in Section [34](#), Chemical Resistance Tests on Sealing and Cementing Compounds;
- d) Be resistant to moisture and aging in compliance with Section [89](#), High Humidity Tests; and
- e) Not be less than 5/8 inch (15.9 mm) deep.

14.1.2.3 The sealing compound shall not flow or creep at the operating temperature of the device, and when it is of the softening type, have a softening point less than 93 °C (200 °F) as determined by ASTM E28.

14.1.2.4 When a nipple is used to retain the sealing compound for the lead wires of the device, the minimum depth of seal required is the internal diameter of the nipple, or 5/8 inch (15.9 mm), whichever is greater. Based on the compound, the size of the lead wires, and the construction of the sealing well, a greater depth of sealing compound shall be necessary to form a tight seal. Means shall be provided in the nipple to anchor the sealing compound.

14.1.3 Leads

14.1.3.1 A lead intended for the connection to the grounded conductor or terminal shall be finished to show a white or gray color and shall be distinguishable from the other leads.

14.1.3.2 The surface of an insulated lead intended solely for the connection to an equipment-grounding conductor or terminal shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

14.1.3.3 The requirements relating to color coding of a lead for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

14.1.3.4 The free length of a lead intended for connection to a device or an appliance shall have a minimum length as specified in (a) – (c), as applicable:

- a) 6 inches (153 mm) when connections are intended to be made within an outlet box or within the equipment enclosure;
- b) 18 inches (458 mm) when connections are not intended to be made within the valve enclosure; or
- c) 24 inches (610 mm) plus the distance between the sealing fitting and the equipment enclosure that is specified in the marking when connections are not intended to be made within an outlet box or within the equipment enclosure, and the equipment is intended to have a sealing fitting installed.

14.1.4 Grounding

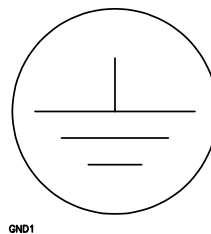
14.1.4.1 All equipment shall have provision for grounding all noncurrent carrying metal parts that are exposed, or that are capable of being contacted by persons during normal operation or adjustment of the equipment and that are capable of becoming energized, in accordance with the requirements in UL 508.

14.1.4.2 A supplemental external bonding terminal provided on the equipment shall have a terminal that is not identified as being intended for connection of the equipment grounding conductor by being:

- a) Colored green;
- b) Marked with the letter or word "G", "GR", "GRD", "GROUND"; or
- c) Marked with the symbol in [Figure 14.2](#).

Exception: The external bonding terminal shall not be identified as an equipment grounding terminal unless instructions are included with the equipment indicating that the internal grounding terminal shall be used as the equipment grounding means and that the external terminal is only a supplemental bonding connection where local authorities permit or require such a connection.

Figure 14.2
Grounding-Terminal Symbol



GND1

(IEC PUBLICATION 417, SYMBOL 5019)

Symbol Definition – A terminal that must be connected to earth ground prior to making any other connections to the equipment.

14.1.4.3 When provided, the supplemental equipotential bonding connection facilities on the outside of electrical equipment shall provide effective connection of a conductor with a cross-sectional area of at least 4 mm² (10 AWG). Effective connection shall be verified by compliance with the pullout and secureness tests in UL 486E.

14.1.4.4 Fixed equipment employing a cord shall comply with the requirements described in [14.2](#), Cord-connected portable equipment.

14.2 Cord-connected portable equipment

14.2.1 General

14.2.1.1 External metal parts of portable equipment that are capable of being struck by or of striking against foreign objects shall be made of brass, bronze, or aluminum.

14.2.1.2 Portable equipment shall have provision for connection of flexible cord listed for extra-hard-usage, with a grounding conductor. The terminal enclosure shall be of a construction such that the cord is replaceable. The enclosure that contains the terminals for connection of the flexible-cord conductors shall completely enclose the terminals.

14.2.1.3 When a power-supply cord is provided, the insulation of the equipment-grounding conductor shall be green with or without one or more yellow stripes and no other conductor shall be so identified. The equipment-grounding conductor shall be connected to the grounding terminal of the equipment by means other than solder.

14.2.1.4 When provided, an attachment plug shall be of the grounding type, intended for use in the same hazardous location classes and groups as the equipment.

14.2.1.5 When a power-supply cord or attachment plug, or both, are not provided, the equipment shall be marked as indicated in [59.14](#).

14.2.2 Terminal enclosure

14.2.2.1 The terminal enclosure for terminals which are capable of turning, either at the screw end, at a head (wire-binding screw), or at a nut in contact with strands of the cord conductor shall:

- a) Withstand the internal pressures resulting from explosions without bursting or loosening at joints;
- b) Have metal-to-metal joints that comply with the requirements in Joints in Enclosures, Section [10](#); and
- c) Withstand a hydrostatic pressure test or be determined to comply with the requirement by calculation as specified in [22.1](#).

14.2.2.2 The terminal enclosure shall be made of metal having a minimum thickness as specified in [Table 9.1](#).

14.2.2.3 When each terminal is of a type that provides a minimum spacing of 3/16 inch (4.8 mm) shortest distance between terminals, is insulated, and does not have a screw end, a head (wire-binding screw), or a nut in contact with strands of the cord conductor, the terminals shall be enclosed, and the explosionproof construction specified in [14.2.2.1](#) is not required to be provided. The entrance for the power-supply cord is not prohibited from being closed with a molded-rubber or -neoprene bushing complying with the requirements in Accelerated Aging Test on Bushings, Section [29](#).

14.2.2.4 Where polarization of the supply is required, cord connectors shall have the terminal intended for connection to the grounded (white) conductor identified by a metal or metal coating substantially white in color, or by the word "white" or the letter "W" located adjacent to the identified terminal. When the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word "white" or the letter "W".

14.2.3 Packing gland

14.2.3.1 A packing gland (stuffing box) shall be provided at the cord entrance to a terminal enclosure that is constructed as described in [14.2.2.1](#).

14.2.3.2 The packing material for the gland shall be polytetrafluoroethylene packing material, or a material having similar characteristics, having a minimum diameter or thickness of 3/32 inch (2.4 mm). The packing material shall completely surround the cord and provide a tightly compressed seal when the packing gland is assembled. The minimum depth of a tightly compressed seal shall be 5/8 inch (15.9 mm).

The construction and amount of packing shall be such that with the packing compressed, as intended, the compression nut still has a travel distance of at least 1/8 inch (3.2 mm) without interfering with parts other than packing material. The compression nut shall be mechanically secured against loosening by means of a setscrew or the equivalent.

14.2.3.3 The diametrical clearance between the outer jacket of the power-supply cord and the surrounding cavity for packing material shall not exceed three times the diameter of the packing material. At each end of the cavity for the packing material, the diametrical clearance between the opening in the gland parts and the outer jacket of the cord shall not exceed:

- a) 1/16 inch (1.6 mm) for packing material less than 1/4 inch (6.4 mm) in diameter; or
- b) 3/16 inch (4.8 mm) for packing material 1/4 inch (6.4 mm) in diameter or larger.

14.2.3.4 All metal surfaces of the gland and terminal enclosure adjacent to the cord shall be smooth and have rounded edges.

14.2.3.5 When a packing gland must be disassembled to replace the power-supply cord, instructions shall be provided for each device covering the intended assembly of the packing gland to the equipment. See [59.13](#).

14.2.4 Cord clamp

14.2.4.1 A positive mechanical cord clamp shall be provided so that the power-supply cord is capable of being readily replaced and strain is prevented at cord connections within the terminal enclosure when subjected to the Strain-Relief Test, Section [30](#). When the cord clamp is threaded to the terminal enclosure, it shall form a tight engagement or shall be secured against turning or loosening by means of a setscrew or the equivalent. The clamp shall be smooth and free from sharp edges that are capable of damaging the jacket of the flexible cord.

14.2.4.2 The cord clamp shall be in addition to the packing gland.

14.2.5 Bonding – Portable equipment

14.2.5.1 Except as indicated in [14.2.5.2](#), all dead metal parts of portable equipment shall be electrically bonded to the terminal for connection of the grounding conductor of the power-supply cord. See Electrical-Resistance Test, Section [28](#).

14.2.5.2 A dead metal part that does not become energized, such as a nameplate, is not required to be bonded when an investigation shows that after such a part has been electrostatically charged, the accumulation does not arc to a grounded probe.

14.2.5.3 A terminal for the connection of an equipment-grounding conductor shall have a permanent identification that is readily recognizable during installation and that is one of the following:

- a) A terminal screw that is not readily removable and that has a green-colored head that is hexagonal, slotted, or both;
- b) A hexagonal green-colored nut that is not readily removable from a threaded terminal stud;
- c) A visible pressure terminal connector that has a green-colored body or appendage that is not readily removable from the connector;
- d) A concealed pressure terminal connector identified in accordance with [14.2.5.4](#); or

e) The letter or word "G," "GR," "GRD," "GND," "Ground," "Grounding," "Green", or by the symbol in [Figure 14.2](#), distinctively marked immediately adjacent to the terminal at least 1/16 inch (1.6 mm) high.

14.2.5.4 When a pressure terminal connector at the equipment-grounding terminal is located within an insulating body and is not visible, the wire-entrance hole for a connection to that terminal shall be identified by one of the following:

- a) A distinct green-colored area immediately adjacent to the wire-entrance hole; or
- b) The letter or word, "G," "GR," "GRD," "GND," "Ground," "Grounding," "Green", or by the symbol in [Figure 14.2](#), distinctively marked immediately adjacent to the wire-entrance hole at least 1/16 inch (1.6 mm) high.

14.2.5.5 A readily removable (not staked or otherwise held captive) part of an equipment-grounding terminal, such as a setscrew or a clamping member, shall not be colored green or otherwise identified as part of the grounding terminal when the part is capable of being interchanged with a similar part of another terminal on the device.

14.2.5.6 When provided, the grounding member of the attachment plug and the grounding conductor of the power-supply cord and dead metal parts of portable equipment required to be bonded in accordance with [14.2.5.1](#) shall be electrically connected as determined by test.

14.2.5.7 External bonding terminals, where provided, shall comply with [14.1.4.2](#).

14.2.5.8 When the terminal for the equipment grounding conductor is readily removable, the area adjacent to the terminal shall be marked in accordance with [14.2.5.4](#).

15 Protection Against Corrosion

15.1 All enclosures of ferrous-metal other than stainless steel shall comply with the applicable requirements for indoor corrosion protection as is found in UL 50E, except at joint surfaces and conduit threads. Joint surfaces and conduit threads are not prohibited from being electroplated.

15.2 Brass, copper, or lead alloy (terne) coatings do not meet the intent of the requirement for coating ferrous-metal parts as protection against corrosion.

15.3 Enclosures made of the following materials are usable for indoor locations without additional corrosion protection:

- a) Copper, aluminum, or stainless steel;
- b) Bronze or brass containing no less than 80 % copper; and
- c) Non-metallic materials.

15.4 For enclosures with dissimilar metals, the effects of galvanic action shall be evaluated.

15.5 Fasteners, or any other part serving to complete or maintain the integrity of the explosionproof enclosure, shall be resistant to corrosion and shall comply with the same requirements as the enclosure.

15.6 Except for flamepaths, both the inside and the outside surfaces of an explosionproof enclosure made of ferrous-metal other than stainless steel shall be protected against corrosion by plating, galvanizing, or painting, or other equivalent means. Enclosures constructed from other metals shall be permitted to be similarly protected.

15.7 A zinc coating on an exterior surface shall have an average thickness not less than 0.0005 inch (0.013 mm) and a minimum thickness not less than 0.0004 inch (0.0102 mm). A zinc coating on an interior surface shall have an average thickness not less than 0.00015 inch (0.0038 mm) and a minimum thickness not less than 0.0001 inch (0.0025 mm).

Exception No. 1: The thickness on interior surfaces not able to be contacted by a 0.75 inch (19.1 mm) diameter ball is not evaluated and the presence of a coating is to be determined by visual inspection.

Exception No. 2: For the surfaces of cast-iron or malleable-iron enclosure materials, the thickness is not evaluated and the presence of a coating is to be determined by visual inspection.

Exception No. 3: Threaded surfaces of tapped holes are not required to be coated.

15.8 Ferrous flamepath surfaces shall be protected against deterioration from corrosion by coating with a corrosion inhibiting material as specified in Section [16](#), Materials Applied to Joint Surfaces, or by electroplating. The metal plating thickness shall not exceed 0.0003 inches (0.008 mm).

15.9 Non-ferrous metallic flamepath surfaces are not prohibited from being coated as specified in Section [16](#), Materials Applied to Joint Surfaces, or electroplated. The metal plating thickness shall not exceed 0.0003 inches (0.008 mm). Aluminum flamepath surfaces that are corrosion protected by anodizing comply with the intent of this requirement.

16 Materials Applied to Joint Surfaces

16.1 A corrosion-inhibiting grease, such as petrolatum or soap-thickened mineral oils are usable on the metal joint surfaces before assembly.

16.2 The grease shall be of a type that does not:

- a) Harden because of aging;
- b) Contain an evaporating solvent; and
- c) Cause corrosion of the joint surfaces.

16.3 A corrosion inhibiting, non-drying, thickened mineral oil-based sealant that does not contain metal particles shall be permitted to be applied to threaded joints.

16.4 Paint or a sealing material shall not be applied to the contacting surfaces of a joint.

Exception No. 1: This requirement does not apply to sealing material that is applied to the contacting surfaces of a joint that is not intended to be and is not required to be opened to install or service the equipment when the application of the material complies with the requirements in [10.3.1](#) and [21.22](#).

Exception No. 2: This requirement does not apply to metallic paint or other non-insulating coating that is applied to a threaded joint surface or a threaded conduit opening that, with the paint or coating applied:

- a) Prevents the passage of flame, hot particles, or sparks capable of igniting the surrounding atmosphere during the explosion tests, see [21.11](#); and*
- b) Complies with the requirements in [28.2.1](#) – [28.2.3](#).*

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

16.6 When a sealing material is applied to a joint surface in accordance with the Exception No. 1 to [16.4](#), explosion tests are to be conducted both with and without the sealing material in place.

16.7 When a device is intended to be provided with a metallic paint or other non-insulating coating on a threaded joint surface or on a threaded conduit opening in accordance with Exception No. 2 to [16.4](#), the explosion tests are also to be conducted on a sample provided with such coating.

17 Devices Having Coated Threaded Joint Surfaces

17.1 The resistance of the grounding path at threaded joint surfaces on which a metallic paint or non-insulating coating has been applied shall not exceed 0.003 ohm.

17.2 A direct- or alternating-current of 50 amperes is to be passed between the two points, one on each of the two parts that comprise the joint, and the resulting drop in voltage potential is to be measured between these points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

18 Porosity in Enclosure Materials

18.1 Porosity not in a joint surface shall not be more than 3/32 inch (2.4 mm) wide and shall not be more than 1/16 inch (1.6 mm) deep. The minimum thickness of the wall from the bottom of a hole to the opposite surface shall not be less than 1/8 inch (3.2 mm), and shall not be affected by porosity holes.

18.2 Porosity in the joint surface greater than 1/64 inch (0.4 mm) wide shall be included in the measurement of the joint width. Holes in the joint surface shall not be more than 1/16 inch (1.6 mm) wide and shall not be more than 1/16 inch (1.6 mm) deep, and the specified minimum width of the joint, not including the holes, shall be provided.

19 Polymeric Enclosures

19.1 An enclosure made of a rigid polymeric material shall have mechanical strength and durability equivalent to a comparable metal enclosure. The enclosure shall be formed so that operating parts are protected against damage, and shall resist the abuses that are encountered during installation and normal use and service.

19.2 Explosionproof electrical enclosures made of rigid polymeric material shall comply with the requirements of Sections [8](#), [10](#) – [17](#), [20](#), [21](#), [22](#), [32](#), and [33](#).

19.3 Explosionproof electrical enclosures made of rigid polymeric material shall comply with the requirements in UL 50.

19.4 When a polymeric enclosure is utilized as an insulating material in connection with a live part, the polymeric material shall be rated for the intended use as an insulator. See UL 746C.

19.5 A polymeric enclosure shall be provided with means of maintaining continuity of the grounding system between grounded rigid metal conduit and dead metal parts within the enclosure that are capable of becoming energized, without relying on the dimensional stability of the polymeric material. An example of this means is a bonding jumper.

PERFORMANCE

20 Temperature Test

20.1 Under operating conditions, equipment shall not attain a temperature at any point on the exterior surface that exceeds:

- a) 100 °C (212 °F); or
- b) The maximum operating temperature or operating temperature class (T Code) marked on the equipment. See [59.3\(i\)](#).

20.2 When the equipment is intended for use in an ambient temperature of 40 °C (104 °F) or less, the test is to be conducted at an ambient of 40 °C. When the equipment is for use in an ambient higher than 40 °C, the test is to be conducted at the higher ambient.

20.3 The operating temperature or operating temperature class shall be based on operation in an ambient as specified in [20.2](#). The temperature class, when provided, shall be in accordance with [Table 59.1](#). For equipment intended and marked for use where Class I and Class II conditions exist simultaneously, the marked operating temperature or operating temperature class is to be based on the temperature attained during the test with dust blanket. See [44.10](#).

20.4 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm²) and not smaller than 30 AWG (0.05 mm²).

20.5 Thermocouples are to be located at various points on the outside of the equipment enclosure.

20.6 A thermocouple junction and the adjacent thermocouple lead wires are to be securely held in thermal contact with the surface of the material, the temperature of which is being measured. Methods of obtaining adequate thermal contact include:

- a) Drilling a small, bottomed hole in the metal, inserting the thermocouple junction and securing it in place by prick-punching the metal adjacent to the drilled hole; or
- b) Placing the thermocouple junction against the surface being measured and securing it in position with a mixture of sodium silicate (water glass) and kaolin.

21 Explosion Tests

21.1 Equipment for use in Class I locations shall comply with the applicable requirements in Section [10](#), Joints in Enclosures, and [21.2](#) – [21.29](#).

Exception: This requirement does not apply to equipment for use in Class I locations that comply with the requirements in Annex [A](#), Alternative Joints in Enclosures, and Annex [B](#), Alternative Explosion Tests.

21.2 Equipment for use in Class I locations shall be subjected to a series of tests conducted in the presence of the specific gas- or vapor-air mixtures over the range of flammable or explosive concentration to determine:

- a) The maximum explosion-pressure effects of the gas- or vapor-air mixtures over the test range specified in [Table 21.3](#);
- b) The maximum propagation effects of the gas- or vapor-air mixtures as specified in [Table 21.3](#); and

c) That an electrical mechanism having contacts does not fail mechanically or electrically in the presence of explosive atmospheres when such tests are required. See [21.5](#) – [21.7](#).

21.3 During the explosion tests, the enclosure shall:

- a) Prevent the passage of flame and sparks capable of igniting the surrounding atmosphere; and
- b) Withstand the internal pressure from the explosions without bursting or loosening of the joints in the enclosure.

21.4 In addition to complying with the requirements in [21.2](#), [21.3](#), and [21.7](#), there shall be no mechanical damage to the electrical mechanism or mechanisms.

21.5 Except as indicated in [21.6](#), [21.7](#), and [21.10](#), tests are to be conducted under stalled-rotor-load conditions. Equipment that is not subject to stalled-rotor-load conditions is to be tested with the maximum electrical test load required for the electrical mechanism when used in ordinary locations.

21.6 Tests for Class I, Groups A or B equipment that is intended for connection to a circuit with a maximum available short circuit current of 10,000 rms symmetrical amperes are to be conducted using a spark plug to ignite the flammable mixture, and by using the arc of the contacts under stalled-rotor-load conditions. Equipment that is not subject to stalled-rotor-load conditions is to be tested with the maximum electrical test load required for the electrical mechanism when used in ordinary locations. For equipment employing a circuit breaker, tests are to be conducted under short-circuit conditions.

Exception: A snap switch not larger than 2 inch² (13 cm²) on any side that is rated not more than 240 V, 20 A, 2 hp is usable in Class I, Group A or B locations without tests conducted using the arc of the contacts when:

- a) The explosionproof enclosure has been found by test to be capable of use in such locations; and*
- b) The switch mechanism has been found by test to meet the requirements for ordinary locations for use at the corresponding rating.*

21.7 For Class I, Group C or D locations, equipment intended for connection to a circuit with a maximum available short-circuit current of 10,000 rms symmetrical amperes is to be subjected to spark plug ignition tests with the intended electrical mechanisms in place. In addition, such equipment for Class I, Group C locations rated over 125 volts is to be subjected to explosion tests to determine that electrical mechanisms having contacts does not fail electrically when operated at maximum rated voltage and a load of nominally 10 amperes or rated current at maximum rated voltage, whichever is lower. The load characteristics are to be the same as the load characteristics required for ordinary-location use when the equipment is subjected to an endurance test. The application of an equivalent load is capable of being used to comply with this requirement.

Exception: A snap switch not larger than 2 inch² (13 cm²) on any side that is rated not more than 240 V, 20 A, 2 hp is usable in Class I, Group C or D locations without tests conducted using the arc of the contacts when:

- a) The explosionproof enclosure has been found by test to be capable of use in such locations; and*
- b) The switch mechanism has been found by test to meet the requirements for ordinary locations for use at the corresponding rating.*

21.8 Equipment rated more than 200 horsepower (149.2 kW output) shall be evaluated for connection to a circuit with an available short-circuit current of more than 10,000 rms symmetrical amperes.

21.9 For equipment rated for connection to a circuit with an available short-circuit current of more than 10,000 rms symmetrical amperes, tests are to be conducted under short-circuit conditions. Tests are also to be conducted using a spark plug to ignite the flammable mixture.

21.10 For Class I, Groups A, B, C, or D locations, equipment having an internal fuse shall be subjected to explosion tests using a spark plug to ignite the flammable mixture, and by overload and short-circuit tests to determine the electrical and pressure effects resulting from rupture of the fuse.

Exception: Equipment using cartridge fuses filled with noncombustible granular material need not be subjected to overload and short circuit tests in the presence of explosive atmospheres if the product is marked in accordance with the requirements of [59.25](#).

21.11 When equipment is intended to be provided with a metallic paint or other non-insulating coating on a threaded joint surface or on a threaded conduit opening, the explosion tests are also to be conducted on a sample provided with such coating. See Exception No. 2(a) to [16.4](#).

21.12 For the explosion tests, the enclosure is to be installed in a test chamber that has inlet and outlet connections to the lines carrying the explosive mixture. The enclosure subjected to tests is to be tapped with threaded holes for connection to the inlet or outlet lines carrying the explosive mixture, attachment of explosion pressure-recording devices, and spark plugs for ignition. The explosive mixture is to be prepared by auxiliary equipment capable of maintaining predetermined concentrations of the mixture.

21.13 When lengths of conduit are required to be connected to the equipment for the explosion tests (see [21.17](#), the conduit is to be used for inlet or outlet connection to the line carrying the explosive mixture. A spark plug is to be located in the conduit length a maximum of 4 inches (10.2 cm) from the outer end.

21.14 The explosive mixture is to be allowed to flow into the enclosure being subjected to explosion tests and into the test chamber until all of the original air has been displaced. The mixture within the enclosure being subjected to tests is then to be ignited either by arcs produced by operation of the electrical mechanism or by a spark plug.

21.15 A series of at least ten tests is to be conducted on each device over the flammable range shown in [Table 21.3](#). Because of the wide range of flammability for hydrogen 15 or more tests is to be conducted in order to cover the flammable range and determine the maximum explosion pressure. An enclosure having a venting section is to be subjected to an additional series of ten explosion tests with 75 % of the venting area sealed.

21.16 Electronic waveforms recorded from pressure sensing devices are to be smoothed using either a 2-kilohertz filter or a computer simulation of a 2-kilohertz filter.

21.17 Equipment is to be tested with lengths of conduit as specified in [Table 21.1](#) when:

- a) It has no current-interrupting contacts, or all current-interrupting contacts hermetically sealed (see [21.27](#)) against the entrance of gases or vapors or immersed in oil; and
- b) It is intended for connection to 1-1/2 inch (48.3 mm OD) and smaller trade sizes of conduit.

Exception: Equipment intended to have sealing fittings attached is not required to be tested with lengths of conduit when it is marked in accordance with [59.17](#).

Table 21.1
Lengths of Rigid Metal Conduit for Explosion Tests

Class I hazardous location Groups	Trade size of conduit inch (mm OD)	Conduit length
A, B, C	Less than 2 (60.3)	5, 10, and 15 feet (1.5, 3.0, and 4.6 m)
D	Less than 2 (60.3)	2 feet (0.6 m)

21.18 With reference to [21.17](#), a hermetically sealed construction is one in which the seal is made by fusion such as soldering, welding, or brazing, or the fusion of glass to metal.

21.19 Equipment having a factory-installed conduit seal is to be subjected to explosion tests on each side of the seal. Lengths of conduit, as specified in [Table 21.2](#), are to be connected to the conduit side of the seal.

Exception: Explosion tests on the conduit side of the seal are not required when the equipment is subjected to the hydrostatic pressure test required by the Exception to [22.2](#).

Table 21.2
Lengths of Rigid Metal Conduit for Explosion Tests on Conduit Seals

Class I hazardous location Groups	Trade size of conduit, inch (mm OD)	Conduit length
A, B, C	All	5, 10, and 15 feet (1.5, 3.0, and 4.6 m)
D	Less than 2 (60.3)	2 feet (0.6 m)
D	2 (60.3) or over	5, 10, and 15 feet (1.5, 3.0, and 4.6 m)

21.20 Gaskets that are provided in addition to the required joints are to be removed for the explosion tests.

21.21 Potting compound, except as used for factory-installed lead wire seals, coil encapsulation, or coil insulation, is to be removed for the explosion tests.

21.22 When a sealing material is applied to a joint surface in accordance with Exception No. 1 to [16.4](#), the explosion tests are to be conducted both with and without the sealing material in place.

21.23 Equipment for Class I, Group A or B locations, or both, that has flat or rabbet type joints is to be tested with the joints reduced to 75 % of the minimum production joint width and the joints shimmed to give a clearance of 50 % more than the maximum production clearance.

21.24 Equipment for Class I, Group A or B locations, or both, that has threaded joints, serrated joints, or both is to be tested with an engagement of 75 % of the total number of engaging threads or engaging serrations to be used. The lateral clearance at the threaded or serrated joints is to be the maximum obtainable in production equipment, including maximum manufacturing tolerances.

21.25 Equipment for Class I, Group A or B locations, or both, that has a free internal volume greater than 30 cubic inches (0.5 dm³) and has a shaft passing through the enclosure is to be tested with the metal-to-metal shaft path reduced to 75 % of the total path length.

21.26 Equipment with a labyrinth joint is to be tested with the joint reduced to 75 % of the total joint width and the joint clearance increased by 50 %.

21.27 A threaded polymeric-to-polymeric joint is to be tested with a thread engagement of 75 % of the minimum number of intended engaging threads.

21.28 The explosive mixtures to be used in the explosion tests are as specified in [Table 21.3](#).

Table 21.3
Explosive Mixtures for Explosion Test

Class I hazardous location Group	Material	Flammable range, percent by volume
A	Acetylene	5.0 – 20.0
B	Hydrogen	15.0 – 35.0
C	Ethylene	4.0 – 9.0
D	Propane	3.0 – 7.0

21.29 For explosionproof equipment specified and marked for use at ambient temperatures lower than minus 25 °C (minus 13 °F), the explosion tests shall be determined by one of the following methods:

a) For explosionproof equipment specified and marked for use at ambient temperatures lower than minus 25 °C (minus 13 °F), the explosion tests shall be performed at the minimum ambient specified, ± 5 °C (± 9 °F). When the ambient specified is such that common materials within the Group are not flammable, a test temperature shall be specified that represents the minimum temperature at which the test gasses shown in [Table 21.3](#) remain gasses, or

b) For equipment for use in Group C or D classified locations, rated not less than minus 60 °C (minus 76 °F), not subject to pressure piling, and determined to comply with the flame propagation requirements in [21.3\(b\)](#), the equipment shall alternatively be subjected to the hydrostatic pressure test using the test factors for low ambient rated equipment found in [Table 22.1](#), based upon room ambient explosion pressure tests, or

c) The reference pressure shall be determined at room ambient temperature (T_a) using the defined test mixture(s), but at increased pressure. The absolute pressure of the test mixture (P) shall be calculated by the following formula, using T_a in °C:

$$P = 100 \left[\frac{293}{(T_a, \text{ min} + 273)} \right] (kPa)$$

or

$$P = 14.6959 \left[\frac{293}{(T_a, \text{ min} + 273)} \right] (psi)$$

21.30 For explosionproof equipment specified and marked for use at ambient temperatures greater than 60 °C (140 °F), flame propagation tests shall be conducted under one of the following conditions:

a) At a temperature not less than the specified maximum ambient temperature; or

b) At normal ambient temperature using the defined test mixture at increased pressure according to the factors in [Table 21.4](#); or

c) At normal atmospheric pressure and temperature, but with the test gap increased by the factors noted in [Table 21.4](#).

These tests are in addition to the explosion tests required to determine compliance with [21.2](#) and [21.3\(a\)](#).

21.31 All test sample joints are to be based upon the manufacturers maximum specified gap, and tested with not greater than 115 % of the minimum specified joint length. Specially prepared test samples having modified joint lengths, gaps and engagements shall be employed. For Groups A, B, or A and B, test factors per [21.23](#) and [21.26](#) are also required to be introduced into the test pressure or test gap in addition to the test factors above by multiplying the test factor of [21.23](#) or [21.26](#), as applicable, by the test factor of [Table 21.4](#).

Table 21.4
Test Factors to Increase Pressure or Joint Test Gap

Temperature up to °C	Groups A & B 27.5% H ₂ 7.5% C ₂ H ₂	Group C 37% H ₂	Group D 55% H ₂	Minimum number of tests ¹
60	1.00	1.00	1.00	5
70	1.11	1.04	1.05	5
80	1.13	1.05	1.06	5
90	1.15	1.06	1.07	5
100	1.16	1.06	1.08	5
110	1.18	1.07	1.09	5
120	1.20	1.08	1.10	5
130	1.22	1.09	1.11	5

¹ The tests are carried out five times with each test mixture. For equipment intended for Group B, only the test with the hydrogen-air mixtures is required.

21.32 A polymeric enclosure or a polymeric enclosure part that forms a portion of an explosionproof joint shall be subjected to the following series of explosion tests:

- At least 100 tests on an enclosure with joints as described in [21.23](#) – [21.27](#), as applicable.
- At least ten tests conducted at the minimum ambient temperature if less than minus 25 °C (minus 13 °F).
- At least ten tests on an enclosure that has been subjected to [33.3.3](#).
- At least ten tests on selected enclosures that have been subjected to the Chemical compatibility by complete end product tests, [33.3](#).
- For a device intended for outdoor use, at least ten tests on an enclosure that has been subjected to the Resistance to Ultraviolet Light and Water Tests in UL 746C.

21.33 A device as specified in [11.2.4](#) and [11.3.1.6](#) shall be:

- Tested with the diametrical clearance of the shaft path increased by 50 % if the device is intended for use in Class I, Group A or B locations; and
- Subjected to five explosion tests in addition to those specified elsewhere in this section using the explosive mixture specified in [Table 21.5](#).