UL 674

STANDARD FOR SAFETY

Electric Motors and Generators for Use in Hazardous (Classified) Locations

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UL Standard for Safety for Electric Motors and Generators for Use in Hazardous (Classified) Locations, UL 674

Sixth Edition, Dated July 29, 2022

Summary of Topics

This new edition of ANSI/UL 674 dated July 29, 2022 includes the following changes in requirements:

– Revisions for the use of electronic medium for required documentation.

– Revisions to include +60 °C and -60 °C explosion testing with test factors using precompression explosion testing equipment.

– Revisions to remove errors and omissions.

– Revisions to replace the oxygen-bomb aging test with the air-oven aging test.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated July 2, 2021 and January 28, 2022.

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Association of Standardization and Certification
NMX-J-652-ANCE
Second Edition

CSA Group
CSA C22.2 No. 145:22
Fourth Edition

Underwriters Laboratories Inc.
UL 674
Sixth Edition

Electric Motors and Generators for Use in Hazardous (Classified) Locations

July 29, 2022

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Approved American National Standard

ANSI/UL 674-2022

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Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as “CSA Group”), and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and UL pages.

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ISBN 978-1-4883-4562-3 © 2022 Canadian Standards Association

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Sixth Edition. The most recent designation of ANSI/UL 674 as an American National Standard (ANSI) occurred on July 29, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 674 on November 6, 1987. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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CONTENTS

Preface 7

1 Scope 9
2 Conditions for Use 9
3 Normative References 10
4 Dated and Undated References 10
5 Definitions 10
6 Components 11
7 Units of Measurement 11
8 Terminology 11
9 Zone and Group Equivalency 11
9.1 Class I, Zone 1, Group IIA 11
9.2 Class I, Zone 1, Group IIB 12
9.3 Class I, Zone 1, Group IIB+H2 12
9.4 Zone 20 and 21 12
10 Enclosures 12
10.1 Material 12
10.2 Porosity in castings 12
10.3 Thickness 13
10.4 Strength 13
11 Joints in Enclosure 14
11.1 General 14
11.2 Groups C and D locations 14
11.3 Group B locations 15
11.4 Class II Locations 16
11.5 Class I and II Locations – Main poles and interpoles of D.C. motors 17
12 Holes in Enclosure 18
13 Shaft Openings 19
13.1 General 19
13.2 Groups F and G locations 20
13.3 Group E locations 20
14 Drain and Breather Plugs in Enclosure 20
15 Air-Gap Gauge Plugs in Enclosure 20
16 Devices with Operating Rods or Spindles 21
17 Protection Against Corrosion 21
17.1 General 21
17.2 Submersible sewage-pump motor 21
18 Materials Applied to Joint Surfaces 21
19 Field-Wiring Connections 22
19.1 Permanently connected motors 22
19.2 Field wiring leads 23
19.3 Equipment grounding terminals and leads 25
20 Cord-Connected Motors 26
20.1 General 26
20.2 Terminal enclosure 27
20.3 Conductor seal 27
20.4 Packing gland 27
20.5 Strain relief 28
20.6 Bonding for grounding 28
20.7 Equipment grounding 29
20.8 Attachment of threaded parts 29
21 Assemblies of Equipment 29
21.1 General 29

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Documents
Document Sharing Hub

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Full document details: UL 674-6 2022

21.2 Electric brake 30
22 External Fans and Fan Guards 30
22.1 Materials 30
22.2 Fan-cooled motor 30
23 Gasoline Submersible Motors 30
23.1 General 30
23.2 Lubrication 30
23.3 Mechanical seal 30
24 Leakage Detectors 31
24.1 Submersible sewage-pump motor 31
24.2 Cord-connected submersible sewage-pump motor 31
25 Maximum External Surface Temperatures 31
26 Devices for Limiting External Surfaces Temperatures 31
27 Spacings 32
27.1 Motors rated 1500 volts or less 32
27.2 Motors rated more than 1500 volts 34
28 Test Voltages and Test Conditions 34
29 Instrumentation – Temperature Measurements 35
30 Variable-Frequency Inverter-Drive Motors 35
31 Temperature Tests – General 35
32 Temperature Tests on Sinewave Power for Single Speed or Multi-Speed Motors 36
32.1 Normal temperature test 36
32.2 Running-overload test 36
32.3 Running-overload to burnout test 36
32.4 Single-phasing test 36
32.5 Locked-rotor test 36
32.6 72-Hour locked-rotor test 37
32.7 Locked-rotor endurance test 37
32.8 Air test 37
32.9 Dry-dust blanket test 38
32.10 Moist-dust blanket test – Group G locations 38
33 Temperature Tests for Variable-Frequency Inverter-Drive Motors 39
33.1 Normal temperature test 39
33.2 Running-overload test 39
33.3 Running-overload to burnout test 39
33.4 Locked-rotor test 40
33.5 Air test 40
33.6 Dry-dust blanket test 40
33.7 Moist-dust blanket test – Group G locations 40
34 Dielectric-Voltage Withstand Test 41
35 Dust-Penetration Test 41
36 Explosion Test 43
36.1 General 43
36.2 Explosion pressure test 43
36.3 Low-ambient explosion pressure tests 44
36.4 Flame propagation test 44
36.5 Elevated ambient flame propagation tests 45
36.6 Exceptions for non-standard joints 45
37 Over Pressure Test on Enclosures 46
38 Dynamic Pressure Test 46
39 Tests on Temperature-Limiting Devices for Limiting External Surface Temperature 46
39.1 Arc-rupturing tests for thermal cut-off device in D.C. motor circuit 46
39.2 Temperature-limiting device in the motor-control circuit 46
39.3 Overload test 47
39.4 Endurance test 47
39.5 Calibration test 47

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Document Sharing Hub

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Full document details: UL 674-6 2022

40 Secureness Test on Conduit Hubs 47
41 Electrical-Resistance Test 47
42 Accelerated-Aging Test on Bushings 47
43 Cord-Pull Test 48
44 Rough-Usage Test 48
45 Drop Test 49
46 Gasoline-Leakage Test 49
47 Non-Metallic Fans and Fan Guards Test 49
47.1 General 49
47.2 Conductivity test 49
47.3 Accumulation of static electricity test 50
48 Pull Test on Tubes 50
49 Sealing Compounds Test 51
50 Low Ambient-Duty Motors 52
50.1 General 52
50.2 Construction 52
50.3 Explosion test 53
50.4 Drop test on lead seal 53
51 Manufacturing and Production Tests – Dielectric Voltage-Withstand Test 53
51.1 Dielectric Voltage-Withstand Test 53
51.2 Grounding-Continuity Test 54
52 Markings 54
53 Installation Instructions 57
53.1 General 57
53.2 Electronic medium for required instructions 57

Annex A (normative) Standard References

Annex B (informative) Standards for components

B1 Component Standards 85

Annex C (normative) Construction for Waiver of Explosion Tests

C1 Explosion tests per the exception to 36.1.2 86
C2 Joints 86
C2.1 General 86
C2.2 Threaded Joints 86
C2.3 Bolts in Joint Width 86
C2.4 Through-bolts 86
C3 Shaft Openings 86
C3.1 Class I Locations 86

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Preface

This is the harmonized ANCE, CSA Group, and UL standard for Electric Motors and Generators for Use in Hazardous (Classified) Locations. It is the second edition of NMX-J-652-ANCE, the fourth edition of CSA C22.2 No. 145, and the sixth edition of UL 674. This edition of CSA C22.2 No. 145 supersedes the previous editions published in 1972, 1986 and 2011. This edition of UL 674 supersedes the previous edition published in 2011.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (CSA), and Underwriters Laboratories Inc. (UL). The efforts and support of the CANENA Technical Harmonization Committee are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Integrated Committee on Hazardous Location Products, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard uses the IEC format but is not based on, nor is it to be considered equivalent to, an IEC standard.

This standard is published as an equivalent standard for ANCE, CSA Group, and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Reasons for differences from IEC

This standard provides requirements for electric motors and generators in accordance with the codes of Canada, Mexico, and the US. At present there is no IEC standard for electric motors and generators for use in accordance with these codes. Therefore, this standard does not employ any IEC standard for base requirements.

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Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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1 Scope

1.1 This standard applies to electric motors and generators or submersible and nonsubmersible sewage pumps and systems suitable for use in Class I, Division 1, Groups B, C and D, and Class II, Division 1, Groups E, F and G, hazardous (classified) locations as defined by CSA C22.1 *Canadian Electrical Code, Part I* (CE Code), the *National Electrical Code*, ANSI/NFPA 70 (NEC), and *NOM-001-SEDE*.

Note: In the US, the application "hazardous locations" is referred to as "hazardous (classified) locations".

1.2 This standard covers the same type of electrical equipment indicated in 1.1 for installation and use in Class I, Zone 1, Groups IIA and IIB, IIB+H_2, and Zone 20 and 21 hazardous locations.

1.3 This standard also covers other rotating machinery such as, but not limited to, electric brakes, tachometers, encoders, and slip rings.

1.4 This standard does not address types of protection other than explosion-proof or dust-ignition-proof.

1.5 For Canada Only – This standard does not include Canadian energy efficiency or product performance requirements. For such requirements, see Annex A, item 19. It is possible that item 19 is referenced in whole or in part in federal, provincial, territorial, or local laws or regulations relating to energy efficiency or product performance. The appropriate governmental authorities should be consulted to confirm whether item 19 has been referenced in laws or regulations.

Note: This standard also does not include U.S. energy efficiency requirements for electric motors used in hazardous (classified) locations.

2 Conditions for Use

2.1 This standard covers motors and generators intended for use under the conditions specified in 2.2 – 2.6.

2.2 Normal ambient duty conditions are defined by the following:

a) An oxygen concentration not to exceed 21 % by volume.

b) A nominal barometric pressure of 101.4 kPa (14.7 psia) (1 atmosphere).

c) Temperature range of minus 25 °C to +40 °C.

d) Altitude not exceeding 1000 m (3281 ft).

In Canada, the normal ambient temperature is minus 50 °C to +40 °C.

2.3 Low ambient duty conditions are considered to be not less than minus 70 °C.

2.4 Products intended and marked for an ambient of lower than minus 25 °C shall be tested (e.g.: explosion pressure test) at 5 °C below the marked lower temperature.

In Canada, products intended and marked for an ambient of lower than minus 50 °C shall be tested (e.g.: explosion pressure test) at 5 °C below the marked lower temperature.

2.5 High ambient duty conditions are considered to be higher than +40 °C.

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2.6 If a motor is rated for use in an ambient higher than +60 °C (+65 °C in Canada), the flame propagation test shall be performed at the marked temperature or greater.

3 Normative References

3.1 Products covered by this standard shall comply with the reference installation codes and standards noted in Annex A as appropriate for the country where the product shall be used. When the product is intended for use in more than one country, the product shall comply with the installation codes and standards for all countries where it is intended to be used.

In Canada, general requirements are as indicated in Annex A, item 18.

4 Dated and Undated References

4.1 For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition.

5 Definitions

5.1 For the purposes of this standard, the following definitions apply.

5.2 AUTOMATIC RESET PROTECTOR – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and automatically closes the circuit once the bimetal has cooled to a lower temperature.

5.3 COMPONENT – Any device which can stand alone and does not require attachment to the motor or generator to comply with hazardous location requirements.

5.4 FLAT (PLAIN, FLANGED, CYLINDRICAL) JOINT– A joint where the path is flat and is not interrupted by steps or threads.

5.5 LABYRINTH JOINT FOR SHAFTS – A joint having at least two axial paths in series, interrupted by at least one radial path having a minimum length of 1.6 mm (0.06 inch).

5.6 MANUALLY RESET PROTECTOR – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and requires manual resetting to close the motor circuit again.

5.7 OPERATING ROD (SPINDLE) – A component of circular cross section used for transmitting control movements that may be rotary or linear or a combination of the two.

5.8 PORTABLE MOTOR – A portable motor is one that can be easily moved. A portable motor incorporates a cord and a plug. A submersible sewage-pump motor, with or without a flexible cord, is not considered a portable motor.

5.9 POWER SHAFT – A component of circular cross section used for transmitting rotary motion.

5.10 RABBET (STEPPED, SPIGOT) JOINT – A joint with two or more surfaces perpendicular to each other in the direction of the path.

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5.11 SINGLE-OPERATION DEVICE – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and is resettable only by cooling to 10 °C lower than the minimum rated ambient of the motor, but not greater than minus 35 °C (minus 31 °F), or lower.

In Canada, a device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and is resettable only by cooling to 10 °C lower than the minimum rated ambient of the motor, but not greater than minus 60 °C (minus 76 °F), or lower.

5.12 THERMAL CUT-OFF – A device that will open a circuit when exposed for a sufficient length of time to a temperature at or above a specified functioning temperature. A thermal cut-off functions once only and will not reverse its function when the temperature is reduced below the functioning temperature.

6 Components

6.1 Except as indicated in 6.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex B for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL Standards as appropriate for the country where the product shall be used.

6.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered in this standard; or

b) Is superseded by a requirement in this standard.

7 Units of Measurement

7.1 The values given in SI (metric) units shall be normative. Any other values given shall be for information purposes only.

8 Terminology

8.1 Where the term "motor" is employed in this standard, it shall be understood that the requirement also applies to a generator or a sewage pump motor.

8.2 The term sewage pump refers to both submersible and non-submersible types unless otherwise specified.

8.3 Paragraphs in this standard that apply to Class I, Class II, or Class I and II, locations are so identified by the following designations appearing after the subclause numbers: (I), (II), or (I, II).

9 Zone and Group Equivalency

9.1 Class I, Zone 1, Group IIA

9.1.1 Explosion-proof electrical equipment intended to be marked in accordance with 52.2 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group D hazardous (classified) locations.

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9.2 Class I, Zone 1, Group IIB

9.2.1 Explosion-proof electrical equipment intended to be marked in accordance with 52.3 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group C hazardous (classified) locations.

9.3 Class I, Zone 1, Group IIB+H2

9.3.1 Explosion-proof electrical equipment intended to be marked in accordance with 52.4 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group B hazardous (classified) locations.

9.4 Zone 20 and 21

9.4.1 Dust-ignition-proof electrical equipment intended to be marked in accordance with 52.7 shall comply with all the requirements for dust-ignition-proof electrical equipment for use in Class II, Group E, F or G hazardous (classified) locations.

10 Enclosures

10.1 Material

10.1.1 (I, II) A motor enclosure shall be made of iron, steel, copper, brass, bronze, or aluminum or its alloys containing not less than 80 % aluminum. A metal such as zinc or magnesium, or their alloys, is not acceptable.

10.1.2 (I, II) To reduce the risk of percussion sparks all exposed metal parts of a portable motor or a cord-connected submersible sewage pump that can be struck by or strike against a foreign object shall be made of:

a) Brass, bronze, or aluminum for a portable motor; or

b) Brass or bronze for a cord connected submersible sewage pump motor.

10.1.3 (I, II) The shaft need not comply with this requirement.

10.1.4 (I, II) For a cord-connected submersible sewage pump provided with a guide-rail system that prevents the pump from contacting other objects while being raised or lowered into the wet pit, only metal parts that could contact the guide rail system and plumbing are required to be made of brass or bronze.

10.2 Porosity in castings

10.2.1 (I, II) Surface porosity not in the joint surface shall not be over 2.4 mm (3/32 inch) wide and not over 1.6 mm (1/16 inch) deep. These holes are not considered as affecting the minimum thickness except that the wall from the bottom of a hole to the opposite surface shall not be less than 3.2 mm (1/8 inch).

10.2.2 (I, II) Surface porosity in joint surfaces shall not be over 1.6 mm (1/16 inch) wide or 1.6 mm (1/16 inch) deep and shall be such that the specified widths of joints are provided, not including the porosity.

10.2.3 (I, II) The porosity level shall be no greater than level 6 as specified in Annex A, item 17.

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10.3 Thickness

10.3.1 (I, II) Except as noted in 10.3.4, the minimum thickness of the enclosure walls shall not be less than that specified in Table 1.

10.3.2 (I, II) A machined or a threaded joint in the walls of a cast-metal enclosure, such as at the end-shield/stator-frame joint, shall have at least the thickness specified in Table 1 through the overlap with neither section less than 1.6 mm (1/16 inch) thick.

10.3.3 (I, II) For an enclosure consisting of different materials such as a steel stator frame and cast-iron end shields, the total thickness through the overlap shall not be less than the minimum required for either of the metals. A section through the overlap shall have a thickness of not less than 1.2 mm (3/64 inch) for a sheet-steel section and not less than 1.6 mm (1/16 inch) for a cast-metal section.

10.3.4 (I, II) For a tube-cooled (totally-enclosed, air-to-air cooled) motor in which the cooling tubes form part of the explosion-proof or dust-tight enclosure, the tubes may be copper, brass, aluminum, or steel, having a wall thickness of not less than 0.76 mm (0.030 inch) if:

a) The tubes are protected against external mechanical damage by an enclosure having a minimum thickness as specified in Table 1; and

b) The tubes are protected against the risk of electrical burn through by:

1) An insulating barrier at least 0.70 mm (0.028 inch) thick between the tubes and any electrical component that is subject to arcing;

2) A grounded metal barrier that will prevent any arcs from electrical parts from reaching the tubes; or

3) Location of components so that no arc from any electrical component, including internal wiring, can contact the tubes.

10.4 Strength

10.4.1 (I, II) The fluid handling section of a canned motor pump shall withstand a pressure equal to 1.5 times the operating pressure for 10 minutes without evidence of leakage into any electrical compartment.

10.4.2 (I) The motor enclosure strength shall be sufficient to withstand the stresses resulting from the Explosion Pressure Test of Clause 36.

10.4.3 (I) The ability of a motor enclosure to withstand internal explosion pressures with sufficient safety factor shall be determined either by calculations or by the Over Pressure Test on Enclosures of Clause 37. The safety factor used for calculations shall be that specified in Table 2.

10.4.4 (I) For a line of motors being covered by tests on a representative motor or motors, the required strength shall be based on the maximum internal explosion pressure recorded during the tests, or the pressure specified in Figure 1, whichever is higher. For a single motor (one frame size with one rating), the required strength shall be based on the maximum internal explosion pressure.

10.4.5 (I) The construction of a tube-cooled motor shall be such that the tubes cannot become dislodged from the main enclosure assembly. See Pull Test on Tubes of Clause 48.

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11 Joints in Enclosure

11.1 General

11.1.1 (I, II) A joint in an enclosure shall be of the metal-to-metal type, and shall be flat, rabbet (stepped), labyrinth or threaded.

11.1.2 (I, II) A metal joint surface shall have an arithmetical average roughness of not more than 0.0064 mm (250 micro-inches) in accordance with the Annex A, item 14.

11.1.3 (I, II) A feeler gauge utilized to measure the clearances specified in these requirements shall be 3.2 mm to 12.7 mm (1/8 inch to 1/2 inch) wide.

11.1.4 (I, II) The clearance shall be considered to comply with the requirement if such a feeler gauge as described in 11.1.3 will not enter the joint for a distance of more than 3.2 mm (1/8 inch) at any point.

11.1.5 (I, II) In the case of cylindrical joints, the clearance shall be considered to comply with the requirement if the difference in the average diameters of the two parts does not exceed the clearance dimensions specified elsewhere in this standard for such a joint.

Note: The diameters shall be measured at four points equally spaced over a total of 135° (0°, 45°, 90°, 135°) around the circumference of both parts and averaged.

11.1.6 (I, II) The width of a joint shall be measured with the mating parts in their most unfavorable position.

11.1.7 (I, II) Except as noted in 11.2.3.1 – 11.2.3.3 and 11.4.3.1 – 11.4.3.3, the width of a joint shall be measured:

a) From the inside of the enclosure to all places around the joint, including the nearest edge of the bolt clearance hole and elsewhere if the bolt head is outside the enclosure; and

b) From the outside of the enclosure to all places around the joint, including the nearest edge of the bolt clearance hole if the bolt head is inside the enclosure.

11.1.8 (I, II) For a rabbet joint, a maximum chamfer of 2.4 mm (3/32 inch) may be provided at the corner to accept a 1.2 mm (1/16 inch) diameter "O" ring (if such an "O" ring is provided). The chamfer shall not reduce the minimum required metal-to-metal width of the joint.

11.1.9 (I, II) Joints in a terminal box shall comply with the requirements in Annex A, items 10 and 12.

11.1.10 (I, II) Joints in a switch enclosure shall comply with the requirements in Annex A, items 10 and 12.

11.2 Groups C and D locations

11.2.1 General

11.2.1.1 (I) Except as noted in Section 36, joints in a motor enclosure shall be as specified in Table 3, Table 5, or Table 6 (informative) as applicable.

11.2.1.2 (I) The minimum joint width in flat (plain) or rabbet (spigot) joints shall be in accordance with Table 3, Table 5, or Table 6 (informative) as applicable, except that the clearance (gap) may be larger

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providing the enclosure meets the flame propagation test with an additional safety factor applied to the test clearance (gap) in accordance with 36.6.

11.2.1.3 (I) The determination of free internal volume shall exclude the volume of any potting and/or sealing compound.

11.2.2 Threaded joints

11.2.2.1 (I) A threaded joint shall consist of the number of fully engaged threads specified in Table 7. Threads shall not be finer than specified in Table 7.

11.2.2.2 (I) The engagement between a threaded shaft (operating rod) and a tapped hole in an enclosure is considered to be a threaded joint.

11.2.3 Bolts in joint width

11.2.3.1 (I) A bolt may be located in the joint width provided that the requirements in Table 3, Table 5, and Table 6 (informative) as applicable, and the minimum effective joint width specified in Table 4 are met. See Figure 4.

11.2.3.2 (I) For a supplementary enclosure, such as a terminal box, device cover, and the like, or other part attached to the motor enclosure, a bolt may be located in the joint width if the joint construction complies with the requirements in 11.2.3.1. See Figure 4.

11.2.3.3 (I) The depth of tapping for the bolt mentioned in 11.2.3.1 and 11.2.3.2 shall permit nominal variations in standard bolt lengths to be accommodated. The use of washers shall be optional, but if used, the bolts shall be capable of securing the part tightly without the washers.

11.3 Group B locations

11.3.1 General

11.3.1.1 (I) The width of a joint in an enclosure having a free internal volume of not more than 0.5 dm^3 (30 cubic inches) shall not be less than 9.5 mm (3/8 inch). 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 9.5 mm (3/8 inch). The clearance between the joint surfaces shall be less than 0.038 mm (0.0015 inch) or such that a 0.038 mm (0.0015 inch) feeler gauge will not enter the joint more than 3.2 mm (1/8 inch) at any point. See Figure 8.

11.3.1.2 (I) For an enclosure having a free internal volume of not more than 0.1 dm^3 (6 cubic inches), the clearance between the joint surfaces shall not be more than 0.10 mm (0.004 inch), and the cover thickness at the joint flange may be less than 9.5 mm (3/8 inch).

11.3.1.3 (I) The width of a joint in an enclosure having a free internal volume of more than 0.5 dm^3 (30 cubic inches) and not more than 1.6 dm^3 (100 cubic inches) shall not be less than 15.9 mm (5/8 inch). 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 be less than 0.038 mm(0.0015 inch) or such that a 0.038 mm (0.0015 inch) feeler gauge will not enter the joint more than 3.2 mm (1/8 inch) at any point. A rabbet joint shall have a total width of not less than 22.2 mm (7/8 inch), with neither section of joint being less than 9.5 mm (3/8 inch) wide. The diametrical clearance at the axial section of joint shall not be more than 0.064 mm (0.0025 inch), and the clearance at the radial or clamped section of joint shall not be more than 0.038 mm (0.0015 inch). See Figure 10.

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11.3.1.4 (I) The width of a joint in an enclosure having a free internal volume of more than 1.64 dm^3 (100 cubic inches) and not more than 5.7 dm^3 (350 cubic inches) shall not be less than 25.4 mm (1 inch). 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 0.038 mm (0.0015 inch).

11.3.2 Bolts in joint width

11.3.2.1 (I) A bolt is not prohibited from being located in the joint width of an enclosure having a free internal volume (air volume) of more than 1.6 and not more than 5.7 dm^3 (100 – 350 cubic inches) when it complies with the requirements in 11.3.2.2 and 11.3.2.3.

11.3.2.2 (I) A bolt is not prohibited from being located in a 25.4 mm (1 inch) 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 21.8 mm (55/64 inch), and the diametrical clearance between the bolt and the clearance hole is not more than 1.14 mm (0.045 inch), 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 11.3.2.5 and Figure 9.

11.3.2.3 (I) 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.

11.3.2.4 (I) A bolt in a joint width is not prohibited from being provided with a lock washer.

11.3.2.5 (I) The requirements in 11.3.2.1 – 11.3.2.3 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 11.3.2.1 – 11.3.2.3, 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.

11.3.3 Threaded joints

11.3.3.1 (I) 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 1.27 mm pitch (20 threads per inch) the minimum number of threads required shall be not less than specified in Table 42 for the class of fit; or

c) For parallel threads not finer than 0.79 mm pitch (32 threads per inch) and tested as described in Explosion Tests – Class I Locations of Clause 36, the minimum number of threads required shall be not less than specified in Table 43.

11.4 Class II Locations

11.4.1 General

11.4.1.1 (II) Except as noted in 35.12, joints in a motor enclosure shall be as specified in Table 8 and Table 9, as applicable.

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11.4.2 Threaded joints

11.4.2.1 (II) A threaded joint shall consist of at least 3 threads fully engaged. Threads shall not be finer than 0.79 mm pitch (32 threads per 1 inch).

11.4.3 Bolts in joint width

11.4.3.1 (II) At a metal-to-metal joint between an inner bearing cap and an end-shield, a bolt may be located in the required joint width if:

a) The bearing cap is secured by bolts or studs extending through the end-shield and engaging tapped holes in the bearing cap (see also 11.4.3.3);

b) The width of joint between the nearest edge of the clearance hole and the interior of the motor enclosure and the clearance between the joint surfaces complies with the requirements in 11.4.1.1;

c) The diametrical clearance between each bolt or stud and its clearance hole is not more than 1.14 mm (0.045 inch), measured over the shank or the major diameter of the threads, for a length of not less than 9.5 mm (3/8 inch); and

d) The width of the joint between the nearest edge of the clearance hole and the interior of the bearing chamber shall not be less than 2.8 mm (7/64 inch) with a clearance between the joint surfaces of not more than 0.05 mm (0.002 inch).

11.4.3.2 (II) The depth of tapping for the bolts or studs mentioned in 11.4.3.1 shall permit nominal variations in standard bolt lengths to be accommodated. The use of washers shall be optional, but if used, the bolts shall be capable of securing the part tightly without the washers.

11.4.3.3 (II) With respect to 11.4.3.1(a), if studs are used and they each engage at least 3 full threads in a tapped hole in the inner bearing cap and are mechanically secured against removal from the bearing cap, the hole need not be bottomed.

11.4.4 Through-bolts

11.4.4.1 (II) – For a through-bolt that secures the end shields and passes through the enclosure, the diametrical clearance between the unthreaded shank of the bolt and the clearance hole in the enclosure (or end shields) shall not be more than 0.25 mm (0.010 inch) for a length of not less than 12.7 mm (1/2 inch).

11.4.4.2 (II) – For a joint between a specially-machined nut and a machined surface on the end shield surrounding the bolt hole, the width of joint shall not be less than 4.8 mm (3/16 inch). The clearance at the joint shall not be over 0.05 mm (0.002 inch) for a 4.8 mm (3/16 inch) wide joint and not over 0.08 mm (0.003 inch) for a 6.4 mm (1/4 inch) wide joint. The width of joint shall be measured from the bolt clearance hole to the nearest outside edge of the nut. In addition, the nut shall fully engage not less than five threads of the through-bolt and a washer shall not be provided.

11.5 Class I and II Locations – Main poles and interpoles of D.C. motors

11.5.1 General

11.5.1.1 (I, II) A d-c motor for Class I, Group D, and Class II locations, with the main poles and interpoles fastened to the stator frame by bolts or studs, shall have a distance from the edge of the pole piece to the bolt hole in the motor frame of not less than 3.2 mm (1/8 inch) if the diametrical clearance between the bolt and bolt hole is not more than 0.58 mm (0.023 inch) for a distance of not less than 12.7 mm (1/2 inch) of the unthreaded bolt shank.

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11.5.1.2 (I, II) The pole piece shall be tightly clamped against the interior of the motor frame with a clearance of not more than 0.10 mm (0.004 inch).

11.5.1.3 (I, II) A lock washer may be used with the bolt. Metal shims may be provided in the joint between a pole piece and the stator frame.

11.5.2 Brush holders

11.5.2.1 (I) A cap of a brush holder shall be provided with metal threads for engaging a metal brush holder mounted through the wall of the motor enclosure.

11.5.2.2 (I) For a motor for Class I locations the number and size of engaged threads shall be as specified in Table 7, and shall have a minimum length of thread-engagement of not less than 8 mm (5/16 inch) as specified in Table 43.

11.5.2.3 (II) For a motor for Class II locations, there shall be at least 3 full threads engaged, and the threads shall not be finer than 1.06 mm pitch (24 threads per 1 inch).

11.5.2.4 (I, II) The insulation provided between the brush holder and the enclosure, and on the brush-holder cap, shall be phenolic composition or the equivalent, and there shall be no exposed live parts. The joints between portions of a brush-holder assembly and between the assembly and the motor enclosure shall comply with the requirements specified for joints in the motor enclosure.

12 Holes in Enclosure

12.1 (I, II) Other than as noted in 12.5, a hole in an enclosure for securing a part, such as a nameplate or a switch, shall be bottomed.

12.2 (I) The remaining thickness at the bottomed hole shall be sufficient to withstand the internal explosion pressures as shown by calculations or by an over pressure test.

12.3 (I) Fastenings such as removable bolts, screws, and studs, shall not leave an opening in the enclosure wall when omitted. The minimum thickness of metal around the hole shall be not less than 3 mm (1/8 inch) or 1/3 of the diameter of the hole, whichever is greater. The minimum thickness of metal at the bottom of the hole shall be not less than 3 mm (1/8 inch) or 1/3 of the untapped diameter, whichever is greater.

12.4 (I, II) The remaining thickness at the bottomed hole shall not be less than 1.6 mm (1/16 inch) when closed by a screw.

12.5 (I, II) A hole in an enclosure may be through-hole when:

a) The hole is closed by a metal pin or part that is press-fitted in the hole for a length of at least 9.5 mm (3/8 inch) for Class I locations, and 4.8 mm (3/16 inch) for Class II locations. The pin or part shall be secured against removal by welding, peening, or the equivalent;

b) The hole is closed by solid and continuous welding of the pin or part that is installed in the hole; or

c) The hole is closed by a bolt or screw that:

1) Does not have more than 0.79 mm pitch (32 threads per inch);

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2) Engages at least 5 full threads for Class I locations and at least 3 full threads for Class II locations. For a self-tapping screw, the number of threads engaged shall be measured when the screw is seated; and

3) Is secured against removal; and if the means for securing is not obvious, the bolt or screw shall withstand the following torques without loosening: for screw size No. 4, 2.8 N-m; No. 5, 4 N-m; No. 6, 4.5 N-m; No. 8, 8.5 N-m; and No. 10, 13.5 N-m.

13 Shaft Openings

13.1 General

13.1.1 (I, II) A shaft opening in a motor enclosure shall be of the metal-to-metal type. See 11.1.2 for the roughness requirements for the metal surfaces forming the path.

13.1.2 (I) Shaft openings in a motor enclosure shall be as specified in Table 10 or Table 12 for Class I, Group C motors, and in Table 11 or Table 12 for Class I, Group D motors. See Figure 2.

13.1.3 (I) The shaft openings specified in Table 10 to Table 12 shall be in addition to any protection offered by the ball bearings or sleeve bearings of the motor.

13.1.4 (I) The length of the shaft opening or path shall be determined by measuring only the metal-to-metal path. Oil or grease grooves with a maximum width of 6.4 mm (1/4 inch) and a maximum depth of 3.2 mm (1/8 inch) shall be acceptable. The total width of the oil or grease grooves (without any inlet or outlet openings) shall not be considered in measuring the effective metal path.

13.1.5 (I) The total actual length of a labyrinth shall be considered as equivalent in length to a straight metal path.

13.1.6 (I) An opening for oil or grease shall be located outside the path in order not to nullify its effectiveness.

13.1.7 (I) If the required shaft path is located between the bearing and the outer surface of the motor, an oil or grease opening shall not be provided unless the construction of the opening provides a length of path not less than that required at the shaft opening.

13.1.8 (I) If a path as specified in Table 10 to Table 12, is not provided in addition to the length of a sleeve bearing, the bearing shall have an overall length of not less than 31.8 mm (1-1/4 inches). The necessary oil openings and grooves may be provided in this 31.8 mm (1-1/4 inches) length of sleeve bearing, subject to tests. In addition, the flame path shall be either:

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

b) Through a labyrinth with an offset not less than 1.6 mm (1/16 inch) [difference in diameters of at least 3.2 mm (1/8 inch)] through two 90° turns. See Figure 3. The labyrinth shall have a diametrical clearance of not more than 0.51 mm (0.020 inch) through a length of not less than:

1) 6.4 mm (1/4 inch) for a motor for Class I, Group D locations; and

2) 9.5 mm (3/8 inch) for a motor for Class I, Group C locations.

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13.2 Groups F and G locations

13.2.1 (II) An outer shaft opening shall have a length of path and diametrical clearance between the shaft and its opening in accordance with Table 13.

13.2.2 (II) A motor provided with an inner shaft opening complying with dimensions specified in Table 14 may have shorter lengths of path and greater clearances at the outer shaft opening if the construction prevents the entrance of dust into the bearing chamber as determined by visual examination following the Dust-Penetration Test – Class II Locations of Clause 35.

13.2.3 (II) For grooves machined in the dust-tight path, the measurements shall be made overall without addition or subtraction of the grooves.

13.2.4 (II) A stationary oil seal may be used at an outer shaft opening if it is in addition to the shaft opening requirements specified in 13.2.1 – 13.2.3.

13.3 Group E locations

13.3.1 (II) The dimensions of a shaft opening in a motor for Group E locations shall not be less than those specified in 13.2.1 – 13.2.2 and shall be such as to prevent the entrance of metal dust into the bearing chamber, as determined by visual examination following the Dust-Penetration Test – Class II Locations of Clause 35.

13.3.2 (II) With reference to 13.3.1, a revolving seal or slinger forming an additional labyrinth path at the shaft opening is generally required to prevent the entry of metal dust into the bearing chamber. A revolving seal employed to prevent entrance of dust shall be made of brass, bronze, or aluminum.

14 Drain and Breather Plugs in Enclosure

14.1 (I, II) A drain plug and a breather plug shall:

a) Perform its intended function without removal of any part;

b) Be located or protected to reduce the likelihood of damage to the plug;

c) Be permanently attached to the enclosure; and

d) Be constructed of corrosion resistant material.

14.2 (I, II) The metal-to-metal joint between a drain plug or breather plug and the enclosure shall comply with the requirements specified for Joints in Enclosure of Clause 11.

14.3 (I) A drain plug or a breather plug shall prevent the passage of flames and sparks capable of igniting the surrounding flammable atmospheres, as in the requirements specified for Explosion Tests of Clause 36.

14.4 (II) A drain plug or breather plug shall prevent the entrance of dust as in the requirements specified for Dust-Penetration Tests of Clause 35.

15 Air-Gap Gauge Plugs in Enclosure

15.1 (I, II) An air-gap gauge plug may be provided if necessary. If provided, the plug shall comply with requirements for threaded joints as applicable in 11.2.2, 11.3.3, and 11.4.2.

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16 Devices with Operating Rods or Spindles

16.1 (I) The path between an opening in an enclosure and an operating rod or spindle shall:

a) Be in accordance with Table 3 or Table 5 and Table 6 for cylindrical or rabbet joints; or

b) Comply with 11.2.2 or 11.3.3 for threaded joints.

16.2 (II) The path between an opening in an enclosure and an operating rod or spindle shall:

a) Conform to the requirements of Table 8; or

b) Be of the threaded type complying with the requirements in 11.4.2.

17 Protection Against Corrosion

17.1 General

17.1.1 (I, II) Iron and steel parts shall be protected against corrosion by painting, enamelling, galvanizing, sherardizing, plating, or other equivalent means. A coating of nitro-cellulose-base paint or enamel shall be free from runs, globules, or accumulations, and its composition shall be such that the paint is not likely to be ignited by impact or by the temperature on the surface to which it is applied.

17.1.2 (I, II) Surfaces of sheet-steel and cast-iron parts within an enclosure need not be protected against corrosion.

17.1.3 (I, II) Internal machined surfaces of a cast-iron stator frame, joint surfaces, shaft openings, bearings, laminations, and minor parts of iron or steel such as washers, screws, and the like, are not required to be protected against corrosion.

17.2 Submersible sewage-pump motor

17.2.1 (I) For a submersible sewage-pump motor, fasteners securing enclosure parts together shall be made of stainless steel or an equivalent corrosion-resistant material.

17.2.2 (I) For a submersible sewage-pump motor, joint surfaces shall be protected by "O" rings, gaskets, or seals located external to the joint fit to reduce the likelihood of the entrance of sewage that may corrode the surfaces. Shaft openings shall be provided with lip or mechanical seals located external to the shaft opening.

18 Materials Applied to Joint Surfaces

18.1 (I, II) Paint or sealing material shall not be applied to the contacting surfaces of a joint. A thin film of oil or grease may be applied to metal-joint surfaces before assembly.

18.2 (I, II) Joint surfaces may be electroplated. The metal plating shall not be more than 0.0076 mm (0.0003 inch) thick.

18.3 (I, II) Paint, paint over-spray, or thread sealant is permitted on conduit entry threads provided the entry passes the conduit entry electrical-resistance test of 41.3 and the gauging requirements of 19.1.1.4 after painting.

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19 Field-Wiring Connections

19.1 Permanently connected motors

19.1.1 Connection for conduit

19.1.1.1 (I, II) Each motor shall have provision for connection to threaded rigid metal conduit, either directly or through a terminal box.

19.1.1.2 (I, II) Threaded conduit entries shall be of the modified National Standard Pipe Taper (NPT) thread, with thread form per Annex A, item 13. Additionally:

a) The taper shall be 1 mm per 16 mm (3/4 inch per foot); and

b) If an integral bushing (historically known as a conduit stop) is provided in the conduit opening of an enclosure for Class I, Group C or D locations, or both, NPS straight threads shall be permitted if there are a minimum of 5 full threads.

19.1.1.3 (I, II) Conduit entries shall not be smaller than trade size 1/2, nor larger than trade size 6; and must be provided with:

a) A minimum of 5 full threads for Class I locations; and

b) A minimum of 3-1/2 full threads for Class II locations.

19.1.1.4 (I, II) Conduit entries shall conform to Annex A, item 13, except that entries shall gauge flush to +3-1/2 turns beyond the L1 gauging notch, in lieu of the minus 1 to +1 turns.

19.1.1.5 (I, II) All male NPT threaded fittings shall have a threaded length not less than the L4 dimension in accordance with Annex A, item 13 from the end of the fitting to the face of a shoulder or to an interruption and shall gauge ±1 turn of the ring gauge from being flush with the end of the thread.

19.1.1.6 (I, II) If an integral bushing (historically known as conduit stop) is provided, it shall be smooth and well-rounded, having a throat or inner diameter as specified in Table 37.

19.1.1.7 (I, II) An attached conduit hub shall have a wall thickness, before threading, of not less than that of the corresponding trade-size conduit. The hub shall not depend upon friction alone to prevent it from turning, and shall withstand the torque specified in the Secureness Test on Conduit Hubs of Clause 40.

19.1.1.8 (I, II) A terminal box provided as part of the motor shall be acceptable for use in at least the same hazardous location Classes and Groups marked on the motor.

19.1.1.9 (I, II) A terminal box that encloses fixed motor terminals for field connection to the power-supply circuit shall be of sufficient size to provide spacings as specified in Table 24, and a useable volume of not less than that specified in Table 15.

19.1.1.10 (I, II) A terminal box that encloses wire-to-wire connections to the power-supply circuit to be made in the field shall have a dimension of opening in the cover and a usable volume of not less than that specified in Table 16 – Table 19.

19.1.1.11 (I) A conduit nipple used for enclosing the wiring leads shall fully engage at least 5 threads in the motor enclosure and shall be secured against turning, or it may be secured to the motor enclosure by a solid and continuous weld. The outer end of the nipple shall have a sufficient number of threads to engage at least 5 full threads.

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19.1.1.12 (I) For a bolted-on box, the joint between the body of the box and the motor shall comply with the requirements in 11.1.9 and 11.2.3.1 – 11.2.3.2.

Note: The thickness of the box body flange may be less than the 9.5 mm (3/8 inch) as required for a 9.5 mm (3/8 inch) wide joint.

19.1.1.13 (I) A terminal box attached to the motor enclosure by a conduit nipple shall engage at least 5 full threads with the nipple.

19.1.1.14 (I) The dimensions of the metal-to-metal joint of a 12.7 mm (1/2 inch) conduit size swivel type conduit fitting shall be as specified in Table 20.

19.1.1.15 (II) A conduit nipple used for enclosing the wiring leads shall fully engage at least 3-1/2 threads in the motor enclosure and shall be secured against turning, or it may be secured to the motor enclosure by a solid and continuous weld. The outer end of the nipple shall have a sufficient number of threads to engage at least 3-1/2 full threads.

19.1.1.16 (II) For a bolted-on box, the joint between the body of the box and the motor shall comply with the requirements in 11.1.9 and 11.4.2 – 11.4.3.3.

19.1.1.17 (II) A terminal box attached to the motor enclosure by a conduit nipple shall engage at least 3-1/2 full threads with the nipple.

19.1.1.18 (II) The dimensions of the metal-to-metal joints of a 12.7 mm (1/2 inch) conduit size swivel type conduit fitting shall be as specified in Table 21.

19.2 Field wiring leads

19.2.1 (I, II) The requirements in 19.2 apply to wiring leads used to make connections in the field. A wiring lead includes a lead connected to an auxiliary device, but does not include thermocouple, resistance temperature detector (RTD), thermistor, resolver, or encoder leads.

19.2.2 (I, II) A wiring lead shall not be smaller than 0.82 mm^2 (18 AWG).

19.2.3 (I, II) The insulation of wiring leads shall be rated for the maximum temperatures to which the leads are subjected during operation of the motor at rated load.

19.2.4 (I) A submersible sewage-pump motor having provision for connection to conduit shall have field-wiring leads at least 3.2 m (10 feet, 6 inches) long.

19.2.5 (I) Wiring leads for motors with fractional horsepower ratings shall be Type TW oil- and gasoline-resistance wire, 90 °C (194 °F) neoprene-insulated wire, or wire with insulation having equivalent resistance to gasoline vapor.

19.2.6 (I) Wiring leads of an integral horsepower frame size motor having a fractional horsepower rating are not required to be of a gasoline-resistance type if the motor is permanently marked: "Not suitable for gasoline dispensing pumps."

19.2.7 (I) For a submersible sewage pump motor, the wiring leads are not required to be oil- and gasoline-resistant.

19.2.8 (I) For a submersible sewage pump motor, individual wiring leads or the jacket of a cord, when used, shall be resistant to water. Thermoplastic material is considered to comply with this requirement.

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19.2.9 (I) The ampacity of wiring leads shall not be less than the maximum rated current of the motor.

19.2.10 (I) Wiring leads connected to an auxiliary device shall have an ampacity acceptable for the current they are intended to carry in accordance with Annex A, item 1, but shall not be smaller than specified in 19.2.2.

19.2.11 (I) Wiring leads passing through an external air chamber of a totally-enclosed, fan-cooled motor shall be enclosed and protected by an integrally cast, explosion-proof passage way, by rigid metal conduit, or the equivalent.

19.2.12 (I) Wiring leads for an auxiliary device shall be insulated for the highest voltage within the terminal box.

19.2.13 (I) Wiring leads shall be sealed where they pass into the motor case. A sealing compound shall be one that will form a tight fit, and that will neither soften nor crack under intended operation at rated load. A sealing compound shall not flow or creep at the operating temperature of the motor. A sealing compound that softens upon the application of heat shall have a softening point of not less than 93 °C (200 °F) for motors having Class A insulation, and 113 °C (236 °F) for motors having Class B insulation. Wiring leads of a Class F or a Class H insulated motor shall be sealed with a setting-type compound. Refer to Sealing Compounds Test in Clause 49.

19.2.14 (I) A determination of the softening point of a sealing compound shall be made in accordance with the Test specified in Annex A, Item 16.

19.2.15 (I) For a motor having a free internal volume of 1000 cm^3 (61 in^3)or less, the depth of seal shall not be less than 12.7 mm (1/2 inch). For a motor having a free internal volume of more than 1000 cm^3 (61 in^3), the depth of the seal shall not be less than 16 mm (5/8 inch) if the motor has frame-to-end-shield joints not exceeding 560 mm (22 inches) in internal length (circumference).

19.2.16 (I) For a motor having a free internal volume of more than 1000 cm^3 (61 in^3), and a frame-to-end-shield joints exceeding 560 mm (22 inches) in internal length (circumference), the depth of seal shall be as specified in Figure 6, but it shall not be less than the outside diameter of the largest lead wire. Depending on the compound, the size of lead wires, and the construction of the sealing well, a greater depth of sealing compound might be necessary to form a tight seal.

19.2.17 (I) For a nipple used to retain the lead wire sealing compound of a motor having a free internal volume of more than 1000 cm^3 (61 in^3), the depth of seal shall not be less than the internal diameter of the nipple, but not less than 16 mm (5/8 inch) deep. Depending on the compound and the size of the lead wires, a greater depth of sealing compound might be necessary to form a tight seal.

19.2.18 (I) Means shall be provided in the nipple to anchor the sealing compound. The completed lead wire seal shall withstand a hydrostatic test pressure of 4 times the applicable explosion pressure (see 10.4).

19.2.19 (I) The depth of a factory-installed seal anchored by mechanical means in a nipple may be less than the internal diameter of the nipple, but not less than 16 mm (5/8 inch).

19.2.20 (II) The ampacity of wiring leads shall not be less than the maximum rated current of the motor.

19.2.21 (II) Wiring leads connected to an auxiliary device (see 19.2.10) shall have an ampacity acceptable for the current they are intended to carry in accordance with Annex A, item 1, but shall not be smaller than specified in 19.2.2.

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19.2.22 (II) Wiring leads passing through an external air chamber of a totally-enclosed, fan-cooled motor shall be enclosed and protected by an integrally cast, dust-ignition-proof passage way, by rigid metal conduit, or the equivalent.

19.2.23 (II) Wiring leads shall terminate in a terminal box that is integral with, or supplied with and attached to, the motor. The terminal box shall be acceptable for use in the same hazardous location Classes and Groups as the motor.

19.2.24 (II) A terminal box need not be provided if the lead wire seal complies with the requirements in 19.2.13 – 19.2.14, and 19.2.25 – 19.2.28.

19.2.25 (II) For a motor having a shaft height of not more than 140 mm (5-1/2 inches), the depth of the seal shall not be less than 11 mm (7/16 inch). For a motor having a shaft height of more than 140 mm (5-1/2 inches), the depth of the seal shall not be less than 16 mm (5/8 inch), or not less than the outside diameter of the largest wiring lead, which ever is greater.

19.2.26 (II) For a nipple used to retain the sealing compound, the depth of the seal shall not be less than the inside diameter of the nipple, or not less than 16 mm (5/8 inch), whichever is greater.

19.2.27 (II) The depth of the sealing compound in a nipple of 19 mm (3/4 inch) trade size and larger may be less than the inside diameter of the nipple, but not less than 16 mm (5/8 inch) if, upon investigation, it is found to provide the required sealing for the application.

19.2.28 (II) Depending on the compound, the size of the wires, and the construction of the sealing well, a depth of sealing compound greater than specified in 19.2.25 – 19.2.26 might be necessary to form a tight seal.

19.2.29 (II) For a seal, provided in addition to a terminal box complying with the requirements in 19.2.23 – 19.2.24, the seal need not comply with the requirements in 19.2.25 – 19.2.28.

19.3 Equipment grounding terminals and leads

19.3.1 (I, II) A motor provided with a terminal box shall be provided with an equipment grounding terminal in the box. The terminal shall be provided for wire-to-wire or fixed terminal connections, and shall be located so that connection to a field-installed equipment grounding conductor can be made within the same box used to enclose the power-supply connections.

19.3.2 (I, II) Where a terminal box has more than one assembly screw, stud, or equivalent securing means for attachment to the motor frame, one of these screws may be suitable for use as the grounding conductor securing means. If one of the assembly screws or studs is so used, a grounding lug shall be supplied to ensure the integrity of the joint.

19.3.3 (I, II) A means for attaching a terminal for a grounding conductor, such as a screw, a tapped hole, a nut and bolt combination, or the like, may be used provided:

a) The means is not likely to be removed during servicing; and

b) The means is located so that the addition of a terminal will not reduce electrical spacings in the terminal box to a value less than the applicable value in Table 24.

19.3.4 (I, II) Motors not supplied with a terminal box and having provision for connection to the power-supply by leads shall have a grounding lead provided as an integral part of the motor. The grounding lead shall be properly bonded to the frame of the motor and shall be brought out external to the motor through a

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sealed opening. This will allow the lead to be suitably enclosed and terminated by acceptable means inside a field-installed terminal box suitable for the location.

19.3.5 (I, II) An equipment grounding lead terminal, or stud, shall be bolted, welded, or otherwise securely bonded to the motor frame or supply connection box. The connection of the equipment grounding lead, terminal, or stud shall not rely upon solder, and shall be located so that it is unlikely to be disturbed during inspection of splices or routine servicing of the motor.

19.3.6 (I, II) An equipment grounding lead shall not be smaller than the equipment grounding conductor to be installed in accordance with Annex A, item 1.

19.3.7 (I, II) An equipment grounding terminal shall be capable of securing a conductor of the size required for the particular application in accordance with Annex A, item 1.

19.3.8 (I, II) The surface of an insulated lead intended for the connection of a field-installed equipment grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

19.3.9 (I, II) An insulated grounding conductor larger than 13.3 mm^2 (6 AWG) may be identified by marking the exposed insulation with green tape or green adhesive labels.

19.3.10 (I, II) A wire-binding screw intended for the connection of an equipment grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector or stud intended for connection of such a conductor shall be plainly identified, such as being marked "G", "GR", "GND", "GROUND", "GROUNDING", or the like, or by a marking on a wiring diagram provided on the motor. The grounding symbol illustrated in Figure 5 may be used as an identifying means; but, if used alone, the symbol shall be defined in the installation instructions provided with the motor.

19.3.11 (I, II) An equipment grounding stud intended to secure a field-installed pressure wire connector shall be provided with a nut to secure the connector. The stud shall be prevented from turning when the nut is tightened.

20 Cord-Connected Motors

20.1 General

20.1.1 (I, II) A portable motor shall be cord-connected. A submersible sewage-pump motor may be cord-connected. A submersible cord-connected sewage-pump motor may also be provided with an auxiliary flexible cord for control and monitor circuits.

20.1.2 (I, II) A cord-connected motor shall employ extra hard usage flexible cord with a grounding conductor in accordance with Annex A, item 1 and shall be constructed to permit replacement of the flexible cord.

20.1.3 (I, II) The enclosure that contains the connections between the flexible cord conductors and the motor terminals or leads shall comply with the requirements in 20.2.1 – 20.2.4 for Class I motors or 20.2.1 – 20.2.3 and 20.2.5 for Class II motors.

20.1.4 (I, II) The construction of the terminal enclosure shall be such that the temperature rise on the insulation and jacket of the cord does not exceed 35 °C (63 °F) when the motor is operated under full-load conditions.

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