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As of the above date, the standard consists of the pages shown in the following check list:

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STANDARD FOR ELECTRIC MOTORS AND
GENERATORS FOR USE IN HAZARDOUS
LOCATIONS, CLASS II, GROUPS E, F, AND G

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FOREWORD

A. This Standard represents the judgment of Underwriters’ Laboratories, Inc., as to the basic requirements for the construction and performance of the products to be Listed under this category. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued Listing of the manufacturer’s product. Underwriters’ Laboratories, Inc., however, assumes no responsibility of the effect of such observance or nonobservance by the manufacturer upon the relations between the manufacturer and any other party or parties arising out of the sale or use of the product or otherwise.

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D. A product employing materials or having forms of construction differing from those detailed in these requirements may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be Listed.

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SCOPE

1. These requirements cover electric motors and generators for installation and use in hazardous locations, Class II, Groups E, F, and G in accordance with the National Electrical Code.

2. These requirements cover both horizontal and vertical machines having fractional and integral horsepower ratings at a maximum of 600 volts alternating current or direct current.

3. These requirements do not cover intrinsically safe motors and generators.

4. If the term “motor” is employed in the following text, it is to be understood that the requirement also applies to a generator.

CONSTRUCTION

General

5. A motor shall be totally enclosed, and it may be fan cooled.

6. A component of a motor shall comply with the requirements for that component, except that such requirements may be modified if appropriate for the particular application.

Enclosure

Material

7. A motor enclosure shall be made of iron, steel, copper, brass, bronze, or aluminum or its alloys containing not less than 80 percent aluminum. A metal such as zinc or magnesium, or their alloys, is not acceptable.

Thickness

8. The minimum thickness of the enclosure walls shall not be less than given in Table 1.

Paragraph 8 effective February 1, 1974.
subject to appreciable aging or plastic flow in the temperature range in which the motor is intended to operate. A gasket shall be mechanically attached and protected from abuse. A minimum gasket contact width of not less than 3/16 inch shall be provided at all points around the joint.

13. A material that readily hardens and/or adheres to metal surfaces upon aging is not considered an acceptable gasket material. The attachment of a gasket by an adhesive or a cement is not acceptable.

14. A feeler gauge utilized to measure the clearances specified in these requirements is to be 1/8-inch wide with the 1/2-inch wide gauge used if possible.

15. Except as noted in paragraph 16, the dimensions of a joint in a motor enclosure shall comply with one of the following:

A. A straight joint shall have a width of not less than 3/16 inch. The clearance between joint surfaces (diametrical clearance for a cylindrical joint) shall not be more than 0.002 inch for a 3/16-inch wide joint and not more than 0.003 inch for a 1/4-inch wide joint.

B. A rabbet joint shall have a width of not less than 3/16 inch. The clearance at the radial section shall not be more than 0.002 inch for a 3/16-inch wide joint and not more than 0.003 inch for a 1/4-inch wide joint. The diametrical clearance at the axial section shall not be more than 0.004 inch for a 3/16-inch wide joint and not more than 0.006 inch for a 1/4-inch wide joint. Neither the axial section nor the radial section of the joint shall be less than 3/64 inch.

16. A motor with metal-to-metal joints having greater clearances with greater widths than those specified in paragraph 15 may be accepted for test.

17. The widths of joint specified in paragraph 15 shall be measured from the interior of a motor to nearest edge of a bolt clearance hole if the bolt head is outside the enclosure and from the exterior of the motor to nearest edge of a bolt clearance hole if the bolt head is within the enclosure.

18. If a rabbet joint is sealed at the corner of the rabbet by a 1/16-inch diameter 0-ring, the 3/32-inch chamfer provided at the corner to accept the 0-ring shall not result in a reduction in the required metal-to-metal joint width.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>THICKNESS OF ENCLOSURE</td>
</tr>
<tr>
<td>Maximum Enclosure Dimensions</td>
</tr>
<tr>
<td>Internal Length of Joint In Inches</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>Over</td>
</tr>
</tbody>
</table>

* - This area is not the total area, but the area of each enclosure part such as the end shield or the stator frame.

- The area of an end shield is considered to be the area of a circle. The area of a stator frame is considered to be the area of a cylinder.

- A motor intended for installation where not subjected to supplementary enclosure may have a minimum thickness of not less than 0.042 inch.

9. 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 given in Table 1 through the overlap with neither section having a thickness of less than 1/16 inch.

Paragraph 9 effective February 1, 1974.

10. If an enclosure consists 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 3/64 inch for a sheet-steel section and not less than 1/16 inch for a cast-metal section.

Paragraph 10 effective February 1, 1974.

Joints

General

11. A joint in an enclosure shall consist of metal-to-metal surfaces. At other than a shaft opening, a gasket may be interposed between the metal-to-metal joint surfaces, if the required metal-to-metal joint width and clearance are provided without the gasket in place. A metal joint surface shall have an arithmetical average roughness of not over 250 micro-inches, in accordance with the American National Standard for Surface Texture, ANSI B46.1–1962.

12. If a gasket is used in a joint, it shall be formed of a material acceptable for the purpose, such as woven asbestos or plant-fiber sheet packing material, or a material of equal characteristics, that is not
Bolts in Joint Width

19. 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;

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 paragraph 15;

C. The diametrical clearance between each bolt or stud and its clearance hole is not more than 0.045 inch, measured over the shank or the major diameter of the threads, for a length of not less than 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 is not less than 7/64 inch with a clearance between the joint surfaces of not more than 0.002 inch.

Paragraph 19 effective February 1, 1974.

20. With respect to paragraph 19, the bolts or studs may be provided with lock washers.

21. With respect to paragraph 19, item A, if studs are used and they each engage at least three full threads in a tapped hole in the inner bearing cap and are mechanically secured against removal, the hole need not be bottomed.

Paragraph 21 effective February 1, 1974.

Through-Bolts

22. If a through-bolt that secures the end shields 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 0.010 inch for a length of not less than 1/2 inch.

23. If a joint is provided 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 3/16 inch. The clearance at the joint shall not be over 0.002 inch for a 3/16-inch wide joint and not over 0.003 inch for a 1/4-inch wide joint. The width of joint is measured from the bolt clearance hole to the nearest outside edge of the nut. In addition, the nut shall fully engage at least five threads of the through-bolt and a washer shall not be provided.

Main Poles And Interpoles

24. A direct-current motor with the main poles and the interpole fastened to the stator frame by bolts (or studs), may have a distance from the edge of the pole piece to the bolt hole in the motor frame of not less than 1/8 inch, provided that the diametrical clearance between the unthreaded shank of the bolt and the clearance hole in the frame is not more than 0.023 inch for a distance of not less than 1/2 inch. The pole piece shall be tightly clamped against the interior of the motor frame with a clearance of not more than 0.004 inch. Suitable metal shims may be provided in the joint between a pole piece and the stator frame. A lockwasher may be used on each bolt.

Brush Holders

25. A brush holder cap shall be provided with metal threads for engaging at least three full threads of a metal brush holder mounted through the wall of the motor enclosure. Threads shall not be finer than 24 per inch. The insulation provided between the brush holder and the enclosure, and on the brushholder cap, shall be phenolic composition or the equivalent, and there shall be no exposed live parts. The joints between parts of a brush holder assembly and between the assembly and the motor enclosure shall comply with the requirements specified for metal-to-metal joints in the motor enclosure.

Holes In Enclosures

26. A metal pin or a part press-fitted through the wall of an enclosure shall engage for at least 3/16 inch. Such a part shall be secured against removal by welding, peening, or the equivalent.

27. Unless attachment conforms to the requirements in paragraph 26 or 28, holes in an enclosure for attachment of a nameplate shall be bottomed. The remaining thickness at the bottomed hole shall not be less than 1/16 inch.

28. A hole in the enclosure for securing a part shall be (1) bottomed, (2) closed by welding of the part in place, or (3) the screw securing the part shall engage at least three full threads and be secured against removal. If a self-tapping screw is used, it shall have a minimum of three full threads engaged when seated. A screw shall not have more than 32 threads per inch.
Shaft Openings

General

29. A special motor, such as a vibrator motor which has eccentric weights on the motor shaft inside of the motor enclosure, may or may not have shaft openings.

30. A shaft opening in a motor enclosure shall be of the metal-to-metal type. See paragraph 11 for the roughness requirements of the metal surfaces forming the path.

Motors For Class II, Groups F And G Locations

31. Except as noted in paragraph 32, an outer shaft opening shall have a length of path of not less than 1/2 inch. The diametrical clearance between the shaft and its opening shall not be more than 0.010 inch for a 1/2-inch length of path, not more than 0.016 inch for a 1-inch length of path, and not more than 0.022 inch for a 1-1/2-inch length of path with intermediate values proportional. Paragraph 31 effective February 1, 1974.

32. A motor provided with an inner shaft opening complying with dimensions given in Table 2, may have shorter lengths of path and greater clearances at the outer shaft opening than those indicated in paragraph 31 provided that they prevent the entrance of dust into the bearing chamber as determined by visual examination following the dust penetration test. Paragraph 32 effective February 1, 1974.

<table>
<thead>
<tr>
<th>Type Of Bearings</th>
<th>Minimum Length Of Shaft Openings, Inches</th>
<th>Maximum Diametrical Clearance, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball or sleeve</td>
<td>1</td>
<td>0.021</td>
</tr>
<tr>
<td>Ball or sleeve</td>
<td>1-1/4</td>
<td>0.023</td>
</tr>
<tr>
<td>Ball or sleeve</td>
<td>1-1/2</td>
<td>0.025</td>
</tr>
<tr>
<td>Ball or sleeve</td>
<td>1-3/4</td>
<td>0.027</td>
</tr>
<tr>
<td>Ball or sleeve</td>
<td>2</td>
<td>0.029</td>
</tr>
<tr>
<td>Ball or sleeve</td>
<td>2-1/2</td>
<td>0.030</td>
</tr>
<tr>
<td>Sleeve</td>
<td>1-1/4 + 1/8 labyrinth</td>
<td>0.020</td>
</tr>
</tbody>
</table>

Table 2 effective February 1, 1974.

33. If grooves are machined in the dust-tight path, the measurements shall be made over all without addition or subtraction of the grooves.

34. A stationary oil seal may be used at an outer shaft opening if it is in addition to the shaft opening requirements given in paragraphs 30–33.

Motors For Class II, Group E Locations

35. The dimensions of a shaft opening in a Group E motor shall not be less than those indicated in paragraph 31 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.

36. With reference to paragraph 35, it has been found that 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 is to be made of metal. Paragraph 36 effective February 1, 1974.

Drain And Breather Plugs In Enclosures

37. A drain plug shall (1) drain a liquid from the motor enclosure without removal of any part of the drain plug, (2) be permanently attached to the enclosure, and (3) be located or protected to prevent damage to the plug.

38. The metal-to-metal joint between a drain plug and the enclosure shall comply with the requirements specified for joints in the motor enclosure or shall be of the threaded type engaging at least three full threads.

39. A drain plug shall prevent the entrance of dust.

40. A breather plug shall comply with the applicable requirements in paragraphs 37–39.

Air-Gap Gauge Plug In Enclosures

41. An air-gap gauge plug shall not be provided in a portable motor or in a ball-bearing motor. Such a plug shall be provided in a sleeve-bearing motor only when necessary and shall engage at least three full threads.

Motors With Integral Switches

42. A switch that is installed within the motor enclosure shall be suitable for the particular application, and shall have a current, voltage and horsepower (if necessary) rating no less than that of the motor which it controls when the motor is operated normally.
43. Except as noted in paragraph 45, the operating shaft of a switch other than a voltage-change switch shall have a length of path of not less than 1/2 inch. The diametrical clearance between the shaft and the opening in the enclosure shall not be more than 0.005 inch for a 1/2-inch length of path, and not more than 0.008 inch for a 1-inch length of path, with intermediate values proportional.

44. Except as noted in paragraph 45, an opening in the enclosure for the operating shaft of a voltage-change switch shall either comply with the requirements in paragraph 43 or the joint requirements in paragraph 15.

45. The path between a switch operating shaft and an opening in the enclosure may consist of at least three fully-engaged threads. Threads shall not be finer than 24 threads per inch.

Protection Against Corrosion

46. Except as noted in paragraph 47, iron and steel parts shall be suitably protected against corrosion by painting, enameling, galvanizing, sherardizing, plating, or other suitable means if the failure of such unprotected parts is likely to result in a hazardous condition. A coating of nitrocellulose-base paint or enamel shall be investigated to determine that it is suitable for the purpose.

47. If the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable — the thickness of the metal and the temperature also being factors — surfaces of sheet-steel and cast-iron parts within an enclosure may not be required to be protected against corrosion. The requirement in paragraph 46 does not apply to internal machined surfaces of a cast iron stator frame, to joint surfaces, shaft openings, bearings, or laminations, or to minor parts of iron or steel such as washers, screws, and the like.

Grease For Joint Surfaces

48. Paint or sealing materials shall not be applied to the contacting surfaces of a joint. A suitable corrosion inhibitor (grease) such as petrolatum, soap-thickened mineral oils, or nondrying slushing compound may be applied to metal joint surfaces before assembly.

49. The grease shall be of a type that does not harden because of aging, does not contain an evaporating solvent, and does not cause corrosion of the metal surfaces.

Power Supply Connections

Permanently Connected Motors

General

50. Each motor shall have provision for connection to threaded rigid conduit either directly or through a conduit box.

51. If provided, a conduit hub or opening shall comply with paragraphs 52–58.

52. An integral conduit stop shall be provided at the inner end of a conduit opening, or sufficient room shall be provided inside of the enclosure for attachment of a conduit bushing to the protruding end of the conduit.

53. If an integral conduit stop is provided, it shall be smooth and well-rounded having a throat or inner diameter as indicated in Table 3.

Paragraph 53 effective February 1, 1974.

<table>
<thead>
<tr>
<th>INNER DIAMETER OF CONDUIT STOP IN INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Size Of Conduit</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1/2</td>
</tr>
<tr>
<td>3/4</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1-1/4</td>
</tr>
<tr>
<td>1-1/2</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>2-1/2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3-1/2</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

Table 3 effective February 1, 1974.

54. If an integral conduit stop is not provided in the conduit opening, the threads shall be tapered 3/4 inch per foot.

55. If an integral conduit stop is provided in the conduit opening, the threads may be of the straight or the tapered type.

56. A conduit opening shall be provided with at least 3-1/2 full threads.
57. If the threads for the connection of conduit are tapped all the way through a hole in an enclosure wall there shall not be less than five full threads and not more than given in Table 4.

Paragraph 57 effective February 1, 1974.

### TABLE 4

**MAXIMUM NUMBER OF THREADS IN A CONDUIT OPENING**

<table>
<thead>
<tr>
<th>Conduit Size, Inch</th>
<th>Number Of Threads Per Inch</th>
<th>Maximum Number Of Threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>3/4</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>11-1/2</td>
<td>8</td>
</tr>
<tr>
<td>1-1/4</td>
<td>11-1/2</td>
<td>8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>11-1/2</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>2-1/2</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>3-1/2</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 4 effective February 1, 1974.

58. Except for a conduit hub integrally cast with an enclosure, a conduit hub shall have a wall thickness before threading not less than that of the corresponding trade-size conduit. The hub shall not depend upon friction alone to prevent its turning, and shall be capable of withstanding the torque specified in paragraph 191.

Paragraph 58 effective February 1, 1974.

59. If a conduit nipple is used for enclosing the wiring leads, it 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.

60. A conduit box provided as part of the motor shall be suitable for use in the same hazardous location classes and groups indicated on the motor.

61. For a bolted-on box, the joint between the body of the box and the motor shall comply with the requirements for joints in the motor enclosure.

62. A conduit box attached to the motor enclosure by a conduit nipple shall engage at least 3-1/2 full threads on the nipple.

63. The dimensions of the metal-to-metal joints of a 1/2-inch conduit size swivel-type conduit fitting shall be as indicated in Table 5.

64. A wiring lead is that lead to which a conductor will be connected in the field.

65. The insulation of the wiring leads shall be suitable for the maximum temperatures to which the leads are subjected during normal operation of the motor.

Paragraph 65 effective February 1, 1974.

66. The ampacity of the wiring leads shall be no less than the input rating of the motor when operating at its maximum rated current.

Paragraph 66 effective February 1, 1974.

67. If the wiring leads pass through the external air chamber of a totally-enclosed, fan-cooled motor, they shall be enclosed and protected by an integrally cast, dust-ignition-proof passageway, by rigid metal conduit, or the equivalent.

68. Except as noted in paragraph 69, the wiring leads shall terminate in a conduit box which is integral with, or supplied with and attached to, the motor. The conduit box shall be suitable for use in the same hazardous location classes and groups as the motor.

### TABLE 5

**DIMENSIONS OF JOINTS IN SWIVEL-TYPE FITTINGS IN INCHES**

<table>
<thead>
<tr>
<th>Minimum Total</th>
<th>Minimum Width Of Clamped Radial Section</th>
<th>Maximum Minimum Width Of Radial Section</th>
<th>Maximum Minimum Axial Clearance At Axial Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16 *</td>
<td>3/64</td>
<td>0.002</td>
<td>3/64</td>
</tr>
<tr>
<td>1/4 *</td>
<td>3/64</td>
<td>0.003</td>
<td>3/64</td>
</tr>
<tr>
<td>3/16 *</td>
<td>—</td>
<td>—</td>
<td>3/16</td>
</tr>
<tr>
<td>1/4 *</td>
<td>—</td>
<td>—</td>
<td>1/4</td>
</tr>
</tbody>
</table>

* — This is a rabbet joint between the fitting and the machined joint surfaces at the lead wire seal of the motor.

b — This is the joint between the hole in the fitting and the unthreaded portion of the screw which secures the fitting to the motor.

Table 5 effective February 1, 1974.

Wiring Leads
69. If a conduit box is not provided, the wiring leads shall be securely held and tightly fitted where they pass into the motor case. If a sealing compound is used, it shall be one which will ensure a tight fit, and which will neither soften nor crack under normal operating conditions. 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 93.3°C (200°F) for motors having Class A insulation, and 113.3°C (236°F) for motors having Class B insulation. The wiring leads of a Class F or a Class H insulated motor shall be sealed with a setting-type compound. A setting-type compound is one that does not melt, soften, or creep upon the application of heat.

70. A determination of the softening point of a sealing compound is to be made in accordance with the American Society for Testing and Materials “Test for Softening Point by Ring and Ball Apparatus,” ASTM E28.

71. For a motor having a shaft height not over 5-1/2 inches, the depth of the seal shall not be less than 7/16 inch. For a motor having a shaft height over 5-1/2 inches, the depth of the seal shall not be less than 5/8 inch, but in no case shall it be less than the outside diameter of the wiring leads.

72. Except as noted in paragraph 74, if a nipple is used to retain the sealing compound, the depth of the seal shall not be less than the internal diameter of the nipple, but in no case shall it be less than 5/8 inch. Paragraph 72 effective February 1, 1974.

73. Depending on the compound, the size of the wiring leads, and the construction of the sealing well, a greater depth of sealing compound than specified in paragraphs 71 and 72 may be necessary to form a tight seal.

74. The depth of the sealing compound in nipples of 3/4-inch conduit size and larger may be less than the inner diameter specified in paragraph 72, but not less than 5/8 inch, if, upon investigation it is found to be suitable and adequate for the particular application. Paragraph 74 effective February 1, 1974.

75. If a lead wire seal is provided in addition to a conduit box complying with the requirements in paragraph 68, the seal need not comply with the requirements in paragraphs 69 - 74.

Cord-Connected Motors

General

76. All external metal parts, except the shaft, of a portable motor that may be struck by or strike against a foreign object shall be made of “non-sparking” material such as brass or aluminum.

77. A portable motor shall have provision for connection of an extra-hard usage flexible Type S, SO, ST, or STO cord with grounding conductor. The terminal enclosure shall be of a construction which permits the cord to be readily replaced. The enclosure that contains the terminals for connection of the flexible cord conductors shall be of substantial construction completely enclosing the terminals.

78. The construction of the terminal enclosure shall be such that the insulation and jacket of the cord do not have a temperature rise of over 35°C (63°F) when the motor is operated under full-load conditions, except as noted in paragraph 79.

79. Consideration will be given to a greater than 35°C (63°F) rise on the insulation and jacket if the cord used is rated more than 60°C (140°F) and if the section of cord having a rise greater than 35°C (63°F) is within an enclosure.

80. If the 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 motor by means other than solder.

81. If provided, the attachment-plug cap shall be of the grounding type, suitable for use in the same hazardous location classes and groups as the motor and connected to the cord as intended.

82. If the power-supply cord and/or attachment-plug cap are not provided, the motor shall be marked as indicated in paragraph 211.

Terminal Enclosure

83. If each terminal is of a type that permits turning of a screw end or head (wire-binding screw) or nut in contact with strands of the cord conductor, the terminal enclosure shall (1) have a substantial construction capable of preventing the entrance of dust and (2) have joints in accordance with paragraphs 15 - 18. The terminal enclosure shall be made of metal having minimum thicknesses as indicated in Table 1.
84. If each terminal is of a type that provides a spacing of at least 3/16 inch (shortest distance) between terminals, is insulated, and does not have a screw end or head (wire-binding screw) or nut in contact with strands of the cord conductor, the terminals shall be enclosed, but the dust-tight construction specified in paragraph 83 need not be provided. The entrance for the connection cord may be closed with a molded rubber or neoprene bushing conforming to paragraphs 192–193.

Packing Gland

85. A packing gland (stuffing box) shall be provided at the cord entrance to the terminal enclosure if constructed as described in paragraph 83.

86. The packing material for the gland shall be braided untreated asbestos rope at least 3/16 inch in diameter, or polytetrafluoroethylene packing material not less than 3/32 inch in diameter or thickness. There shall be a sufficient amount of packing material to completely surround the cord and provide a tightly compressed seal when the packing gland is assembled. The depth of tightly compressed seal shall be at least 5/8 inch. The construction and amount of packing shall be such that with the packing properly compressed, the compression nut still has a travel distance of at least 1/8 inch without interfering with parts other than packing material.

87. The compression nut shall be mechanically secured against loosening by means of a setscrew or the equivalent.

88. The diametrical clearance between the outer jacket of the flexible 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 (1) 1/16 inch for polytetrafluoroethylene or asbestos rope less than 1/4-inch diameter, or (2) 3/16 inch for polytetrafluoroethylene or asbestos rope 1/4-inch diameter or larger.

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

90. If it is necessary to disassemble a packing gland to permit replacement of the power supply cord, an instruction sheet shall be provided with each motor covering the proper assembly of the packing gland to the motor. See paragraph 210.

Cord Clamp

91. A positive mechanical cord clamp shall be provided that (1) permits the flexible supply cord to be readily replaced and (2) prevents strain at the cord connections within the terminal enclosure when subjected to the pull test described in paragraphs 194–195. If 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 may damage the jacket of the flexible cord.

Bonding

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

93. Except as noted in paragraph 94, all noncurrent-carrying metal parts of a portable motor shall be electrically bonded to the terminal for the connection of the grounding conductor of the connection cord.

94. A noncurrent-carrying metal part which is not liable to become energized, such as a nameplate, need not be bonded, if an investigation shows that a dangerous amount of static electricity will not accumulate on such a part.

95. The 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 which is hexagonal-shaped, slotted, or both.

B. A hexagonal green-colored nut that is not readily removable from a threaded terminal stud.

C. A visible pressure wire connector that has a green-colored body or appendage that is not readily removable from the connector.

D. A concealed pressure wire connector identified in accordance with paragraph 90.
96. If a pressure wire connector at the equipment-grounding terminal is located within the insulating body and is not readily 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.
   
   B. The letter or word, "G," "GR," "GND," "GROUND," "GROUNDING," or "GREEN" distinctively marked immediately adjacent to the wire-entrance hole in letters at least 1/16-inch high.

97. 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 if the part may be interchanged with a similar part of another terminal on the device.

98. If provided, the grounding member of the attachment-plug cap and the grounding conductor of the power supply cord and dead-metal parts of portable equipment required to be bonded in accordance with paragraph 93 shall be electrically connected as determined by test.

99. The resistance of the grounding path between the terminal for connection of the grounding conductor of the power supply cord and dead-metal parts of the portable equipment required to be bonded in accordance with paragraph 93 shall not exceed 0.1 ohm.

100. With regard to paragraph 99, the resistance may be determined by any convenient method except that if unacceptable results are recorded, either a direct- or alternating-current of 15 amperes is to be passed from the grounding terminal to all noncurrent-carrying metal parts required to be bonded in accordance with paragraph 93, and the resulting drop in potential is to be measured between these two 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.

101. Threaded parts forming dust-ignition-proof joints in a terminal enclosure shall be secured against loosening by means of a setscrew or the equivalent located outside of the required threaded joint.

Assemblies Of Equipment

102. If a piece of electrical equipment, such as an electric brake, a tachometer, or a bearing thermostat, is attached to an electric motor, one or more of the hazardous location classes and groups designated on the equipment and the motor shall be in common.

103. If an electric brake is marked to specify that the brake is to be mounted to the motor at the motor manufacturer's factory, the assembly to the motor shall comply with the requirements for enclosure joints and shaft openings in this Standard.

104. In the case of a motor-generator set, one or more of the hazardous location classes and groups designated on the motor and the generator shall be in common.

External Fans And Fan Guards

105. The external fan on a fan-cooled motor shall be substantially mounted with ample clearance between revolving and stationary parts.

106. An external fan shall be constructed of "non-sparking" material.

107. Medium brass or aluminum, with a hardness not over Rockwell B66, complies with the requirement in paragraph 106 with respect to material.

108. A nonmetallic fan shall be suitable for the intended use when judged with regard to the generation of electrostatic charges.

109. Unless the fan of a fan-cooled motor is provided with a guard as specified in paragraphs 111–112 that protects against accidental contact with blades, spokes, or other irregular surfaces of the fan or shaft, it shall be marked as specified in paragraph 213.

Paragraph 109 effective February 1, 1974.

110. For the purpose of these requirements, a guarded fan-cooled motor is one in which all openings giving direct access to the fan are limited in size by the design of the structural parts, or by screens, grills, expanded metal, etc.

Paragraph 110 effective February 1, 1974.

111. Except as indicated in paragraph 112, an opening in a guard or an opening between the guard and the motor that will not permit entrance of a 3/4-inch diameter rod is acceptable if a probe as illustrated in Figure 1 cannot be made to touch any moving part other than a smooth shaft when inserted through the opening.

Paragraph 111 effective February 1, 1974.
MOTORS AND GENERATORS. CLASS II, GROUPS E, F, AND G — UL 674(A) APRIL 7, 1972

112. An opening in a guard or an opening between the guard and the motor may be greater than 3/4-inch wide, but not greater than 1-1/2-inch wide, provided the width is not more than one-eighth of the distance to the nearest moving part other than a smooth shaft.

Paragraph 112 effective February 1, 1974.

113. A Class F or H insulated motor for Class II, Group G hazardous locations shall be provided with a temperature-limiting device in the motor enclosure to prevent the external surface of the motor from exceeding 165°C under any operating condition (including locked rotor and single phasing) while packed with moisture bearing dust.

Paragraph 113 effective February 1, 1974.

114. For a motor with other than Class F or H insulation systems and without a temperature-limiting device, temperature tests shall show that the specific insulation system used provides protection equivalent to a temperature-limiting device.

Paragraph 114 effective February 1, 1974.

115. A motor that may exceed maximum safe temperatures shall be provided with a temperature-limiting device within the motor enclosure. The temperature-limiting device shall prevent exterior surface temperatures from exceeding the maximum safe temperature when operated in the dust tightness and dust blanketing temperature tests. The maximum safe temperatures are given in Table 6.

Paragraph 115 effective February 1, 1974.

### TABLE 6

<table>
<thead>
<tr>
<th>Class II, Group</th>
<th>Under Full Load Operating Conditions</th>
<th>Under All Operating Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>200°C (392°F)</td>
<td>200°C (392°F)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>150°C (302°F)</td>
<td>200°C (392°F)</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>120°C (248°F)</td>
<td>165°C (329°F)</td>
<td></td>
</tr>
</tbody>
</table>

- Includes stalled rotor and single-phasing.
- See paragraphs 113 and 160.

Table 6 effective February 1, 1974.

116. Except as noted in paragraph 117, a temperature-limiting device for a motor rated 3/4 horsepower or less shall open the motor circuit directly.

Paragraph 116 effective February 1, 1974.

117. Multispeed motors and other motors having wye-delta connections, rated 3/4 horsepower or less, may be provided with a thermostat complying with the requirements in paragraphs 122 - 123.

Paragraph 117 effective February 1, 1974.

118. A motor provided with an inherent overheating protective device and marked "Thermally Protected" shall comply with the requirements for such devices.

Paragraph 118 effective February 1, 1974.

119. A thermal protector complying with the requirements for such a device may be used as a surface temperature-limiting device provided it also complies with the requirements in paragraph 115.

Paragraph 119 effective February 1, 1974.

120. If a manually-replaceable thermal cutoff (fusible link) is employed to prevent overheating of the exterior surface of the motor enclosure, the cutoff shall not be adversely affected by aging, and shall open the motor circuit under the conditions described in paragraph 166, item B and in paragraph 173.

Paragraph 120 effective February 1, 1974.

121. A thermal cutoff (fusible link) complying with the requirements for such a device is not considered to be adversely affected by aging.

Paragraph 121 effective February 1, 1974.

122. If a temperature-limiting device is not available to directly open the circuit to a large motor, the temperature-limiting device may be a thermostat connected to operate the controller in the motor circuit. Such a thermostat does not contain an integral heater. The thermostat leads are intended for connection in series with the stop button of a three-wire pilot circuit of a magnetic controller connected to the motor. At least two temperature-limiting devices to monitor different phase windings may be necessary for a three-phase motor.

Paragraph 122 effective February 1, 1974.
123. A motor provided with a temperature-limiting device that does not open the motor circuit directly shall be marked as indicated in paragraph 215.

Paragraph 123 effective February 1, 1974.

Spacings

124. The spacing between field-wiring terminals of opposite polarity, and between a field-wiring terminal and any other uninsulated metal part (dead or live) not of the same polarity, shall not be less than the value indicated in Table 7.

Paragraph 124 effective February 1, 1974.

125. If an isolated dead-metal part is interposed between or is in close proximity to (1) live parts of opposite polarity, (2) a live part and an exposed dead-metal part, or (3) a live part and a dead-metal part that may be grounded, the spacing may not be less than 3/64 inch between the isolated dead-metal part and any one of the other parts previously mentioned, provided the total spacing between the isolated dead-metal part and the two other parts is not less than the value indicated in Table 7.

Paragraph 125 effective February 1, 1974.

126. At terminal screws and studs to which connection may be made in the field by means of pressure wire connectors, soldering lugs, etc., it is required that the spacings not be less than those shown in Table 7 when the connectors, lugs, etc., are in such position that minimum spacings (opposite polarity and to dead metal) exist when the terminals are turned 30 degrees toward each other, or toward other uninsulated parts of opposite polarity or toward grounded metal parts.

Paragraph 126 effective February 1, 1974.

127. A wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless (1) the wire and (2) a means of making the connection (a pressure terminal connector, soldering lug, solder loop, crimped eyelet, etc.) factory-assembled to the wire, are provided as a part of the motor.

Paragraph 127 effective February 1, 1974.
TABLE 9
MINIMUM ACCEPTABLE SPACINGS IN INCHES AT MOTOR CIRCUIT AND PILOT CIRCUIT TEMPERATURE-LIMITING DEVICES

<table>
<thead>
<tr>
<th>Parts Involved And Voltage</th>
<th>Not Larger Than 1/3 Hp</th>
<th>Larger Than 1/3 Hp But Not Larger Than 1 Hp</th>
<th>Over 1 Hp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through Air</td>
<td>Over Surface</td>
<td>Through Air</td>
</tr>
<tr>
<td>A. Between an uninsulated live part and uninsulated live part of opposite polarity or an exposed dead metal part other than the enclosure:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 150 volts</td>
<td>1/16</td>
<td>1/16</td>
<td>1/16</td>
</tr>
<tr>
<td>151 - 300 volts</td>
<td>1/16</td>
<td>3/32</td>
<td>1/16</td>
</tr>
<tr>
<td>301 - 600 volts</td>
<td>1/8</td>
<td>1/4</td>
<td>1/8</td>
</tr>
<tr>
<td>B. Between an uninsulated live part and the enclosure, if of other than sheet metal:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 150 volts</td>
<td>1/16</td>
<td>1/16</td>
<td>1/16</td>
</tr>
<tr>
<td>151 - 300 volts</td>
<td>1/16</td>
<td>3/32</td>
<td>1/16</td>
</tr>
<tr>
<td>301 - 600 volts</td>
<td>1/8</td>
<td>1/4</td>
<td>1/8</td>
</tr>
<tr>
<td>C. Between an uninsulated live part and a sheet metal enclosure, including a cap or cover:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 300 volts</td>
<td>1/8</td>
<td>1/4</td>
<td>1/8</td>
</tr>
<tr>
<td>301 - 600 volts</td>
<td>1/4</td>
<td>3/8</td>
<td>1/4</td>
</tr>
</tbody>
</table>

Table 9 effective February 1, 1974.

129. The spacing requirements given in paragraphs 124 - 128 do not apply to the inherent spacings of a component of the motor, such as a temperature-limiting device or a snap switch. Such spacings are judged on the basis of the requirements for the component in question. The spacing requirements given in these paragraphs do apply between a component live part and adjacent metal parts. For a repulsion motor, a repulsion-induction motor, or a repulsion-start-induction motor, the spacing requirements do not apply to the commutator, the brush assembly, and the jumpers which short-circuit the brushes. Any uninsulated conductor of the rotor circuit is regarded as a dead-metal part with respect to the stator circuit, and the appropriate spacing is required between uninsulated stator and rotor conductors.

Paragraph 129 effective February 1, 1974.

130. The spacings between parts of the motor and a temperature-limiting device mounted in the motor enclosure shall not be less than that indicated in Table 9.

Paragraph 130 effective February 1, 1974.

131. Insulating barriers as described in paragraphs 132 - 137 may be provided as part of or in lieu of the spacings specified in paragraphs 124, 128, and 130.

Paragraph 131 effective February 1, 1974.

132. Except as noted in paragraph 134, an insulating barrier or liner used as the sole separation between an uninsulated live part and a grounded dead-metal part (including the enclosure) or between uninsulated live parts of opposite polarity, shall be of material that is suitable for the mounting of uninsulated live parts and is a nominal 1/32-inch thick (0.028 inch minimum).

Paragraph 132 effective February 1, 1974.

133. Barriers as referred to in paragraph 131 do not pertain to slot liners or slot cells in the motor insulation system.

Paragraph 133 effective February 1, 1974.

134. Fiber having a nominal thickness of 1/32 inch (0.028 inch minimum) may be used as the sole separation between the enclosure and an uninsulated metal part electrically connected to a grounded circuit conductor, if the operating temperature of the fiber is not more than 90°C (194°F).

Paragraph 134 effective February 1, 1974.
135. Except as noted in paragraph 136, an insulating barrier or liner that is used in addition to an air space in lieu of the required spacing through air shall be a nominal 1/32 inch thick (0.038 inch minimum). If the barrier or liner is of fiber, the air space shall not be less than 1/32 inch, and if the barrier or liner is of material that is not suitable for the mounting of uninsulated live parts, the air space provided shall be adequate for the particular application.

Paragraph 135 effective February 1, 1974.

136. A barrier or a liner that is used in addition to not less than one-half the required spacing through air may be less than 1/32 inch but shall have a nominal thickness of 1/64-inch (0.013 inch minimum) provided that the barrier or liner is of material that is (1) suitable for the mounting of uninsulated live parts, (2) of adequate mechanical strength if exposed or otherwise liable to be subjected to mechanical injury, (3) reliably held in place, and (4) located so that it will not be adversely affected by operation of the equipment in service.

Paragraph 136 effective February 1, 1974.

137. Insulating material having a thickness less than that indicated in paragraphs 132, 135 and 136 may be used if, upon investigation, it is found to be suitable and adequate for the particular application.

Paragraph 137 effective February 1, 1974.

**PERFORMANCE**

**General**

138. The performance of a motor shall be investigated by subjecting representative samples to all the applicable tests as described in paragraphs 139 – 201. If practical, the tests shall be conducted in the order in which they are presented here.

139. For the tests described in paragraphs 146 – 167, the motor is to be coupled to a generator, dynamometer, or other loading equipment, and operated at rated frequency, and at full rated load (except as noted in paragraph 160) based on the voltage indicated in Table 10.

Paragraph 139 effective February 1, 1974.

140. If agreeable to all concerned, the test conditions described in this Standard may be modified provided that the results of the modified tests can be considered to cover the results that would be obtained under the conditions described.

141. Temperatures are to be measured by thermocouples consisting of wires no larger than No. 24 AWG and no smaller than No. 30 AWG. Where thermocouples are used in determining temperatures in electrical equipment, it is standard practice to employ thermocouples consisting of No. 30 AWG iron and constantan wire and a potentiometer-type instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

142. Thermocouples are to be located at various points on the outside of the motor enclosure and at other points where temperature measurements are required.

143. A thermocouple junction and the adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material whose temperature is being measured. Adequate thermal contact is obtained by 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. The adjacent thermocouple leads may be held in contact with the external surface of the enclosure with a cement consisting of water, glass and silica.

144. In the tests described in paragraphs 146 – 157, a continuous duty motor shall be operated at the voltage indicated in Table 10 and at full rated load (or service factor, if so marked) until thermal equilibrium occurs. For an intermittent duty motor, the motor shall be operated at the voltage indicated in Table 10, at full rated load (or service factor, if so marked) and at the rated time-temperature duty cycle until the maximum temperatures are attained. For a torque motor, the motor shall be operated under stalled conditions.

Paragraph 144 effective February 1, 1974.

145. The tests described in paragraphs 146 – 166 shall be conducted at a 40°C (104°F) ambient.
Temperature In Air

146. A cord-connected motor and a motor provided with a temperature-limiting device are to be operated as indicated in paragraph 144.

Paragraph 146 effective February 1, 1974.

147. Temperature-limiting devices (whether provided to limit surface temperatures, or not), in the motor circuit or pilot circuit, shall not open during this test.

Paragraph 147 effective February 1, 1974.

148. The temperature rise attained on the insulation and jacket of the flexible cord of a cord-connected motor shall not exceed that specified in paragraphs 78 - 79.

Dust Tightness

149. The motor is to be installed in a test chamber of a size sufficient to prevent other than normal heating of the motor and to permit free circulation of the dust-air mixture around the motor during the test. The test chamber is to be provided with a cover and with dust-air inlet and outlet connections.

150. During this test, the motor is to be operated as indicated in paragraph 144 while exposed to a circulating dust-air atmosphere in the test chamber. The motor is then allowed to cool to ambient temperature. This procedure is to be repeated for at least 6 cycles of operation or for 30 hours, whichever is greater.

151. Except as noted in paragraph 152, the motor shall exclude dust. The dust in contact with the enclosure shall not ignite or become charred as determined by a color change of the dust.

152. For grain dust, a barely visible film of dust may be permitted to enter the bearing housing if there is no excessive heating of the bearing and an inner shaft path complying with Table 2 is provided between the bearing and the interior of the motor.

153. Grain dust consisting of wheat and/or corn dust that has passed through a 100 mesh screen shall be used in the test if the motor is for use in Class II, Groups F and/or G locations.

154. Magnesium dust, all of which has passed through a 60 mesh screen, 66 percent of which has passed through a 100 mesh screen, and 22 percent of which has passed through a 200 mesh screen, shall be used in the test if the motor is for use in Class II, Group E, Groups E and F, or Groups E, F, and G locations.

Temperature With Dry-Dust Blanket

155. The motor shall be installed in a test chamber as described in paragraph 149 and exposed to the circulating dust-air atmospheres until the blanket of dust on the motor is stabilized. The motor is then operated as indicated in paragraph 144.

156. During this test, the dust in contact with the motor enclosure shall not ignite or discolor (from heat) and the temperature of the exterior surface of the motor enclosure shall not exceed 120°C (248°F) for a Class II, Group G motor or 200°C (392°F) for a Class II, Group E or F motor.

157. If a motor is intended for Class II, Group F, Group G, Groups F and G, or Groups E, F, and G locations, the tests are to be conducted with grain dust. If the motor is intended for Class II, Group E locations only, the tests are to be conducted with magnesium dust.

Temperature With Moist-Dust Blanket

158. A motor for Class II, Group G locations shall be subjected to temperature tests where the motor is packed with moisture-laden dust consisting of approximately 45 percent finely sifted grain dust and 55 percent water, by weight. A flour-water mixture may be used in place of the grain dust-water mixture.

Paragraph 158 effective February 1, 1974.

159. The moisture-laden dust shall be packed on the motor to the approximate accumulated depths attained in the dry-dust-blanket temperature test.

Paragraph 159 effective February 1, 1974.

160. The temperatures on the exterior surfaces of the motor shall not exceed 165°C (329°F) under all operating conditions including overload, single-phasing, and locked rotor. This maximum safe temperature shall not be exceeded in the interval after the motor is disconnected from the circuit, whether disconnected manually or by an integral temperature-limiting device, if provided.

Paragraph 160 effective February 1, 1974.
161. The dust in contact with the motor shall not char or ignite during the test.
   Paragraph 161 effective February 1, 1974.

162. If a temperature-limiting device is provided in the motor, it shall operate at a temperature which will prevent burn-out of the motor and prevent external temperature from exceeding 165°C (329°F).
   Paragraph 162 effective February 1, 1974.

163. Thermocouples are to be located at various points on the outside of the motor enclosure.
   Paragraph 163 effective February 1, 1974.

164. A motor without a device for limiting the external surface temperature is to be operated as indicated in paragraph 160 to obtain maximum external temperatures. The supply voltage shall be in accordance with Table 10.
   Paragraph 164 effective February 1, 1974.

165. The tests described in items A, B, and C of paragraph 166 are to be conducted at the voltage indicated in Table 10 except that in item A an intermittent duty motor may be operated at a reduced voltage as indicated.
   Paragraph 166 effective February 1, 1974.

166. For a motor provided with a device for limiting the external surface temperature the following tests are to be conducted:

   A. To determine whether or not the temperature on the external surface of the motor enclosure will exceed the safe temperature limits under overload conditions, the motor is to be coupled to a generator, dynamometer, or other loading equipment, and the load is to be adjusted to result in the maximum motor current obtainable without tripping of the temperature limiting device. For an intermittent-duty motor, the test is to be conducted at the prescribed time-temperature duty cycle of the motor, or the motor may be operated continuously at a reduced load and, if necessary, at a reduced voltage to obtain the maximum motor current obtainable without tripping of the temperature-limiting device.

   B. Under locked-rotor conditions, a motor having an automatic-resetting temperature-limiting device in the motor circuit is to be permitted to cycle on and off for 72 hours. A motor with a manually-resettable temperature-limiting device is to be operated as rapidly as possible until maximum temperatures are reached, or for a maximum of 10 cycles of operation, whichever occurs first. A motor provided with a thermal cutoff (fusible link) is to be subjected to at least three locked-rotor tests with a new cutoff being used for each test.

   C. Under locked-rotor conditions, a motor having a temperature-limiting device in the control circuit is to be subjected to one cycle of operation.
   Paragraph 166 effective February 1, 1974.

167. The 72 hour test described in item B of paragraph 166 is not to be considered as part of the 15 day test described in paragraphs 169–171.
   Paragraph 167 effective February 1, 1974.

Temperature-Limiting Devices
For Limiting External Temperatures

Temperature-Limiting Device
In The Motor Circuit

168. A motor provided with a temperature-limiting device in the motor circuit for limiting the external temperatures shall be subjected to the tests specified in paragraphs 169–174.
   Paragraph 168 effective February 1, 1974.

Locked Rotor

169. Except as noted in paragraph 170, an automatic-reset temperature-limiting device shall operate for 15 days with the motor for which it is designed. There shall be no permanent injury to the motor, including excessive deterioration of the insulation.
   Paragraph 169 effective February 1, 1974.
170. An automatic-reset temperature-limiting device may permanently open the circuit prior to the expiration of the time given in paragraph 169, provided (a) it is specifically designed to do so, and (b) testing of three samples show that it will do so consistently and reliably without grounding to the motor frame, injury to the motor, or evidence of any fire hazard.

Paragraph 170 effective February 1, 1974.

171. A manually-reset temperature-limiting device shall open the motor circuit for 50 operations without damage to itself. The temperature-limiting device is to be reclosed as quickly as it can be made to do so after each opening of the circuit. There shall be no permanent damage to the motor, including excessive deterioration of the insulation.

Paragraph 171 effective February 1, 1974.

172. During the tests mentioned in paragraphs 169-171, the rotor of the motor is to be locked, and the enclosure of the protector is to be connected to ground through a 30 ampere cartridge fuse. The voltage of the power supply circuit is to be 100-110 percent of the voltage indicated in Table 10.

Paragraph 172 effective February 1, 1974.

Arc Rupturing

173. A direct-current motor provided with a thermal cutoff (fusible link) connected directly in series with the windings of the motor shall be subjected to the following test in addition to those specified in paragraph 166, item B. At least three cutoffs in turn, shall be connected in series with only the shunt winding of the motor. With the shunt winding circuit connected to an electrical supply, the ambient air temperature shall be gradually increased until the cutoff operates. There shall be no burning of the cutoff and no striking of an arc to ground.

Paragraph 173 effective February 1, 1974.

Dielectric Withstand

174. A temperature-limiting device shall withstand for 1 minute without breakdown the application of a 60 Hertz essentially sinusoidal potential applied between live parts of opposite polarity, and between live parts and dead-metal parts which are grounded. The test potential shall be 900 volts for a device intended to protect a motor rated at 1/2 horsepower or less and 250 volts or less. For all other motor ratings, the test potential shall be 1000 volts plus twice the rated voltage of the motor which the device is intended to protect.

Paragraph 174 effective February 1, 1974.

175. The test potential is to be supplied from a suitable 500 volt-ampere or larger-capacity testing transformer, the output voltage of which can be regulated. The waveform of the voltage should approximate a sine wave as closely as possible. The applied potential is to be increased from zero until the required test value is reached, and is to be held at that value for 1 minute. The increase in the applied potential is to be at a substantially uniform rate and as rapidly as consistent with its value being correctly indicated by the voltmeter.

Paragraph 175 effective February 1, 1974.
TABLE 11
STANDARD ELECTROMAGNETIC LOADS FOR TEMPERATURE-LIMITING DEVICES IN MOTOR CONTROL CIRCUIT*

<table>
<thead>
<tr>
<th>Rated Voltage</th>
<th>Test Voltage</th>
<th>Standard Duty</th>
<th>Heavy Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overload</td>
<td>Normal Current</td>
<td>Current Inrush</td>
</tr>
<tr>
<td>110 – 120 ac</td>
<td>132</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>220 – 240 ac</td>
<td>264</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>440 – 480 ac</td>
<td>528</td>
<td>0.75</td>
<td>7.5</td>
</tr>
<tr>
<td>550 – 600 ac</td>
<td>660</td>
<td>0.6</td>
<td>6</td>
</tr>
<tr>
<td>115 – 125 dc</td>
<td>138</td>
<td>1.1</td>
<td>2.2</td>
</tr>
<tr>
<td>250 – 250 dc</td>
<td>275</td>
<td>0.55</td>
<td>—</td>
</tr>
<tr>
<td>550 – 600 dc</td>
<td>660</td>
<td>0.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

* — A load other than those described in Table 11 may be used after due consideration of the need for the device to control an electromagnet having other characteristics, the means utilized for matching the rating of the device to that of the load, and the completeness of the marking.

— Power factor, 0.35 or less.

Table 11 effective February 1, 1974.

Temperature-Limiting Device In
The Motor Control Circuit

176. The insulation of a temperature-limiting device (in the motor control circuit) which is relied upon to limit the external temperatures shall be suitable for the temperatures obtained in normal full load (or service factor) operation of the motor. There shall be no permanent damage to the motor, including excessive deterioration of the insulation in tests of the temperature-limiting devices in the control circuit.

Paragraph 176 effective February 1, 1974.

177. There shall be no electrical or mechanical failure or any undue burning, pitting, or welding of the contacts of a temperature-limiting device in the motor control circuit when subjected to the tests specified in paragraphs 178 – 181.

Paragraph 177 effective February 1, 1974.

178. A temperature-limiting device in the motor control circuit shall be subjected to 50 cycles (break only) of overload operation. Test voltage and the associated electromagnet load shall be as indicated in Table 11. A new sample may be used for each overload test potential for which the device is rated.

Paragraph 178 effective February 1, 1974.

179. A temperature-limiting device in the motor control circuit shall be subjected to 10,000 cycles (break only) of operation. The test voltage and the associated electromagnet load shall be as indicated in Table 11. A new sample may be used for each endurance test potential for which the device is rated, except that each device shall be subjected to the appropriate overload test before the endurance test is conducted. A device that has been tested for 6000 cycles of make and break operation is considered to comply with this requirement.

Paragraph 179 effective February 1, 1974.

180. A temperature-limiting device shall be calibrated in accordance with the requirements covering the component. The device is to be calibrated both before and after the overload and endurance tests.

Paragraph 180 effective February 1, 1974.

181. A temperature-limiting device shall withstand for 1 minute without breakdown the application of a 60 Hertz essentially sinusoidal potential applied between live parts of the temperature-limiting device and the motor enclosure. The test potential shall be 1000 volts plus twice the maximum rated voltage of the temperature-limiting device. The test potential applied between the motor winding and the motor enclosure with the temperature-limiting device leads grounded to the motor enclosure shall be 1000 volts plus twice the rated voltage of the motor. Also, see paragraph 175.

Paragraph 181 effective February 1, 1974.
Auxiliary Temperature-Limiting Devices

Temperature-Limiting Device In
The Motor Circuit

182. A motor provided with a temperature-limiting device (in the motor circuit) which is not relied upon to limit external temperatures shall be subjected to the tests specified in paragraphs 183–187.

Paragraph 182 effective February 1, 1974.

Locked Rotor

183. Except as noted in paragraph 184, an automatic reset temperature-limiting device shall operate for 72 hours with the motor for which it is designed. There shall be no permanent injury to the motor, including excessive deterioration of the insulation.

Paragraph 183 effective February 1, 1974.

184. An automatic-reset temperature-limiting device may permanently open the circuit prior to the expiration of the time given in paragraph 183, provided (a) it is specifically designed to do so, and (b) testing of three samples show that it will do so consistently and reliably without grounding to the motor frame, injury to the motor, or evidence of any fire hazard.

Paragraph 184 effective February 1, 1974.

185. A manually-reset temperature-limiting device shall open the motor circuit for 10 operations without damage to itself. The temperature-limiting device is to be reclosed as quickly as it can be made to do so after each opening of the circuit. There shall be no permanent damage to the motor, including excessive deterioration of the insulation.

Paragraph 185 effective February 1, 1974.

186. During the tests mentioned in paragraphs 183–185, the rotor of the motor is to be locked, and the enclosure of the protector is to be connected to ground through a 30 ampere cartridge fuse. The voltage of the power supply circuit is to be 100–110 percent of the rated voltage of the motor.

Paragraph 186 effective February 1, 1974.

Dielectric Withstand

187. A temperature-limiting device shall be subjected to the dielectric withstand test described in paragraph 174.

Paragraph 187 effective February 1, 1974.

Temperature-Limiting Device In
The Motor Control Circuit

188. A motor provided with a temperature-limiting device (in the motor control circuit) which is not relied upon to limit the external temperatures shall be subjected to the tests specified in paragraphs 189–190. There shall be no electrical or mechanical failure or any undue burning, pitting, or welding of the contacts of a temperature-limiting device when subjected to these tests.

Paragraph 188 effective February 1, 1974.

Overload

189. A temperature-limiting device in the motor control circuit shall be subjected to 10 cycles (break only) of overload operation. The test voltage shall be as indicated in Table 10. The load used shall be compatible with the intended function and the assigned ratings of the temperature-limiting device. A new sample may be used for each overload test potential for which the device is rated.

Paragraph 189 effective February 1, 1974.

Dielectric Withstand

190. A temperature-limiting device shall be subjected to the dielectric withstand test described in paragraph 181.

Paragraph 190 effective February 1, 1974.

Secu reness Of Conduit Hubs

191. A conduit hub not integrally cast with a metal enclosure shall be capable of withstanding the specified torque applied to a short length of rigid conduit threaded into the hub of the enclosure in the intended manner, without turning in the enclosure and without stripping of any threads. The applied torque shall be 800 pound-inches for 1/2- and 3/4-inch sizes, 1000 pound-inches for 1-, 1-1/4-, and 1-1/2-inch sizes, and 1600 pound-inches for 2-inch and larger sizes.

Paragraph 191 effective February 1, 1974.

Accelerated Aging Of Bushings

192. A molded rubber or neoprene bushing provided at the cord entrance to the terminal enclosure of a cord-connected motor shall show no greater change in hardness than five numbers (0.005 inches) as a result of a 96 hour exposure to oxygen at a pressure of 300±10 pounds per square inch gauge at a temperature of 70±1°C (158.0±1.8°F).
193. If possible, the complete molded-rubber or neoprene bushing is to be tested. The hardness of the rubber or neoprene is to be determined as the average of five readings with a suitable gauge, such as a Rex hardness gauge or Shore durometer. The bushing is then to be exposed to oxygen for 96 hours at the pressure and temperature referred to in paragraph 192. The apparatus for oxygen pressure aging is to consist of a high pressure steel vessel or bomb equipped with a removable cap and a safety release mechanism; pressure gauges, piping, and fittings for introducing oxygen into the interior of the bomb; a water bath or other suitable means for maintaining the bomb at a controlled temperature as specified; and temperature- and pressure-recording instruments. The bushing or specimen thereof is to be not more than 2 grams per cubic inch of space within the bomb. With the bushing or specimen in place, the bomb is to be sealed and then placed in a suitable water bath or the equivalent. This bomb is then to be filled with oxygen at the required pressure and maintained at the specified temperature for the required length of time. Temperatures are to be recorded throughout the period of heating. At the end of the exposure period, the pressure within the bomb is to be reduced to atmospheric pressure at a rate not greater than 150 pounds per square inch per minute. The bushing or specimen is to be removed from the bomb and then cooled at room temperature for at least 4 hours. The hardness is to be determined again as the average of five readings. The difference between the original hardness average reading and the average reading taken after exposure to oxygen is the change in hardness.

Cord Pull

194. For a cord-connected motor, there shall be no strain at the cord conductor connections or damage to the cord when a direct pull is applied to the extension of the flexible cord for 1 minute. A force of 150 pounds shall be applied if the motor is rated 30 amperes or less. If the motor is rated over 30 amperes, a force of 300 pounds shall be applied.

195. With the flexible cord connected to the motor as intended in service, the cord clamp of the motor is to be held firmly and a gradual pull provided by use of a pulley and weights at the cord extension is to be applied.

Rough Usage

196. A cord-connected motor not provided with a base or stand shall be subjected to a rough usage test. The motor, terminal enclosure, and the cord clamp shall not be impaired nor shall threaded engagements be loosened during this test.

197. The portable motor is to be suspended in a vertical position, with cord clamp up, by means of a short loop formed from a heavy solid wire. The connecting cord is to be removed from the device and one end of the wire loop connected to the motor at its cord clamp. The other end of the wire loop is to be extended through a screw eye secured to a solidly mounted vertical board, 2-inches thick. The free end of the portable motor is to be pulled away from the board and then allowed to swing back against the board, or a wooden block secured thereto, for 9000 times at a rate of about 50 times per minute, the horizontal swing distance being about 6 inches.

198. Following the rough usage test, the motor shall withstand for 1 minute without breakdown the application of a 60 Hertz sinusoidal potential of 1000 volts plus twice maximum rated voltage. The potential is to be applied between live parts and dead-metal parts of the motor.

Drop

199. A drop test shall be conducted on a cord-connected motor unit that is liable to be dropped while handling. The motor, terminal enclosure, and the cord clamp shall not be impaired when the motor is dropped to a concrete floor ten times from a height of 3 feet.

200. For the first five drops during the test, the motor, with cord connected as in service, is allowed to freely fall in a manner that would normally be the case if the device were to fall from a horizontal platform to the floor. In the remainder of the test, the motor with cord is to be held at various angles about 3 feet above the concrete floor and then dropped to the floor.

201. Following the drop test, the motor shall withstand for 1 minute without breakdown the application of a 60 Hertz sinusoidal potential of 1000 volts plus twice maximum rated voltage. The potential is to be applied between live parts and dead-metal parts of the motor.
MANUFACTURING AND PRODUCTION TESTS

Dielectric Withstand

202. Each motor shall withstand without breakdown, as a regular production-line test, the application of a 60 Hertz essentially sinusoidal alternating test potential as described in paragraphs 203 and 204.

Paragraph 202 effective February 1, 1974.

All Motors

203. The test potential is to be applied between live parts and dead-metal parts. If the motor is equipped with an auxiliary device, such as a thermostat, heater, etc., the auxiliary device leads or terminals are to be grounded to the motor enclosure during the test. The potential is to be applied for 1 minute and is to have a value of (1) 900 volts if the rating of the motor is 1/2 horsepower or less and 250 volts or less, and (2) twice rated voltage plus 1000 volts for a motor of any other rating; except that the time of application of the potential may be reduced to 1 second if the value of the test potential is 120 percent of that indicated.

Paragraph 203 effective February 1, 1974.

Motors With Auxiliary Devices

204. The test potential is to be applied between live parts of the auxiliary device and the motor enclosure. The potential is to be applied for 1 minute and is to have a voltage of twice rated voltage of the auxiliary device plus 1000 volts except that the time of application of the potential may be reduced to 1 second if the value of the test potential is 120 percent of that indicated.

Paragraph 204 effective February 1, 1974.

Test Equipment

205. The test equipment is to include a visual indication of application of the test potential and an audible and/or visual indication of breakdown. In the event of breakdown, manual reset of an external switch is to be required, or an automatic reject of the unit under test is to result. A 500 volt-ampere or larger capacity transformer need not be used in tests by the manufacturer if the transformer is provided with a suitable voltmeter to directly measure the applied output potential.

Paragraph 205 effective February 1, 1974.

Bonding

206. The manufacturer shall determine by routine production line test that the grounding member of the attachment plug, if provided, or the grounding conductor of the supply cord is electrically conductively connected to dead-metal parts of a portable motor.

MARKING

207. A motor shall have a metal nameplate marked with the following information:

A. Manufacturer’s name and catalog designation or equivalent.
B. Rated volts and full load amperes.
C. Rated full load speed.
D. (1) Rated temperature rise or (2) the insulation system class and rated ambient temperature.
E. Time rating.
F. Except as noted in paragraph 214, rated horsepower if 1/8 horsepower or more.
G. Locked rotor indicating code letter if an alternating-current motor (other than a polyphase wound rotor motor) rated 1/2 horsepower or more.
H. Secondary volts and full load amperes if a wound rotor induction motor.
I. Rated frequency and number of phases, if an alternating-current motor.
J. Winding — straight shunt, stabilized shunt, compound, or series, if a DC motor.
K. Designation of the hazardous location in which the motor is intended to be used: i.e. “Class , Group .”
L. The maximum operating temperature or the operating temperature indicating code number as indicated in Table 12. The operating temperature or operating temperature indicating code number shall be on the nameplate close to the marking required by item K. It shall be properly identified: i.e. “Operating Temperature ___,” or “Operating Temperature Code ___.”

Paragraph 207 effective February 1, 1974.
TABLE 12
OPERATING TEMPERATURE INDICATING CODE NUMBERS

<table>
<thead>
<tr>
<th>Maximum Temperature</th>
<th>Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deg C</td>
<td>Deg F</td>
</tr>
<tr>
<td>280</td>
<td>536</td>
</tr>
<tr>
<td>260</td>
<td>500</td>
</tr>
<tr>
<td>230</td>
<td>446</td>
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<td>215</td>
<td>419</td>
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<td>200</td>
<td>392</td>
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<td>150</td>
<td>320</td>
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<td>135</td>
<td>275</td>
</tr>
<tr>
<td>120</td>
<td>248</td>
</tr>
<tr>
<td>100</td>
<td>212</td>
</tr>
<tr>
<td>85</td>
<td>185</td>
</tr>
</tbody>
</table>

Table 12 effective February 1, 1974.

208. The metal nameplate referred to in paragraph 207 shall be permanently attached to the motor by means such as drive pins or drive screws. An adhesive-attached nameplate may be used if it is found, by investigation, to be adequate and suitable for the application. Ordinary usage of the motor is considered in regard to the suitability of an adhesive-attached plate.

209. Each cord-connected motor shall be provided with suitable marking instructions regarding replacement of the power supply cord. These instructions shall be legible and permanent in nature. These instructions may be a paper label if located within the terminal compartment and free from mechanical damage.

210. Each cord-connected motor employing a packing gland which has to be dismantled during cord replacement shall be provided with suitable marking instructions regarding its installation and/or replacement.

211. A cord-connected motor which is produced without power supply cord and/or the attachment plug cap attached shall be provided with suitable instructions regarding the installation of these components. The instructions shall include all required information regarding the type of cord and the attachment plug cap that must be provided.

212. A single phase capacitor motor having a capacitor, or capacitors, exterior to the motor enclosure shall be provided with a diagram indicating the proper connections. If the capacitor is not mounted in a dust-ignition-proof enclosure, the diagram shall indicate that the capacitor case is to be mounted outside of the hazardous area.

Paragraph 212 effective February 1, 1974.

213. A fan-cooled motor that does not comply with the requirements for guarding in paragraphs 110 - 112, shall be marked “Fan Not Guarded.” This marking shall be on the nameplate or permanently marked on the motor in some other manner.

Paragraph 213 effective February 1, 1974.

214. A torque motor shall be marked as indicated in paragraph 207 except that the locked rotor torque shall replace horsepower.

Paragraph 214 effective February 1, 1974.

215. A motor provided with a temperature-limiting device (for limiting external temperatures) that does not open the motor circuit directly shall be supplied with an instruction sheet and/or a wiring diagram of the temperature limiting device circuit on a plate or tag. The wiring diagram or instruction sheet shall include the ratings of the temperature-limiting device and the identification of the leads, and shall indicate that a manual momentary start switch is required. If the load controlled by the temperature-limiting device is likely to exceed the values given in Table 11, the wiring diagram shall show the use of an intermediate control circuit relay.

Paragraph 215 effective February 1, 1974.

216. A motor provided with auxiliary equipment, such as heaters or a temperature-limiting device not relied upon to limit external temperatures, shall be supplied with an instruction sheet and/or a wiring diagram of the auxiliary device circuit on a plate or tag. The instruction sheet or wiring diagram shall include the rating of the auxiliary device and the identification of the leads.

Paragraph 216 effective February 1, 1974.
HOW STANDARDS ARE DEVELOPED
BY UNDERWRITERS' LABORATORIES

UL Standards for Safety are developed under a procedure which provides for participation and comment from the affected public as well as industry. The procedure takes into consideration a survey of known existing standards, and the needs and opinions of a wide variety of interests concerned with the subject matter of the Standard. Thus manufacturers, consumers, individuals associated with consumer-oriented organizations, academicians, government officials, industrial and commercial users, inspection authorities, insurance interests and others provide input to UL in the formulating of UL Standards for Safety, and keeping them consonant with social and technological advances.