UL 79B

STANDARD FOR SAFETY

Power-Operated Pumps for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations up to 20 Percent (B20), Kerosene, and Fuel Oil

UL Standard for Safety for Power-Operated Pumps for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations up to 20 Percent (B20), Kerosene, and Fuel Oil, UL 79B

First Edition, Dated February 11, 2015

Summary of Topics

This revision of ANSI/UL 79B dated June 3, 2020 includes the addition of reference to UL 61800-5-1 as a replacement to UL 508C; 30.5.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 20, 2020.

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UL 79B

Standard for Power-Operated Pumps for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations up to 20 Percent (B20), Kerosene, and Fuel Oil

Prior to the first edition, the requirements for the products covered by this standard were included in the Outline of Investigation for Power-Operated Pumps for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations up to 20 Percent (B20), Kerosene, and Fuel Oil, UL 79B.

First Edition

February 11, 2015

This ANSI/UL Standard for Safety consists of the First Edition including revisions through June 3, 2020.

The most recent designation of ANSI/UL 79B as an American National Standard (ANSI) occurred on May 14, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to 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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INTRODUCTION

1 Scope

1.1 These requirements cover products described in 1.2 when used with one or more of the fuels described in 1.3.

1.2 These requirements cover electrically-, hydraulically-, or pneumatically-driven power-operated pumps for use with petroleum products in the following applications:

a) Self-contained dispensing devices and submerged pumps used in storage tanks that provide the fuel to remote control dispensing devices. They are intended for operation at discharge pressures of 50 pounds per square inch (psig) (345 kPa), or the marked maximum discharge pressure rating, when less, with the ambient and liquid temperature within the range of minus 29°C (minus 20°F) – 52°C (125°F).

b) Dispensing systems to transfer the fuel from a tank or container to a vehicle or another container. They are intended for operation at the marked maximum discharge pressure, or less, with the ambient and liquid temperature within the range of minus 29° C (minus 20° F) – 52° C (125°F).

c) Vapor recovery applications for dispensing devices. They are intended to operate under a vacuum at the inlet and a maximum discharge pressure of 50 psig (345 kPa), or marked discharge pressure, whichever is less.

1.3 Pumps covered by these requirements are intended for use with one or more of the following:

a) Diesel Fuel, which includes renewable diesel and diesel/biodiesel blends with nominal biodiesel concentrations up to 5 percent (B0 – B5) formulated in accordance with the Standard Specification for Diesel Fuel Oils, ASTM D975.

b) Diesel/biodiesel, renewable diesel/biodiesel blends, blends with nominal biodiesel concentrations from 5 percent up to 20 percent (B6 – B20) formulated in accordance with the Standard Specification for Diesel Fuel Oil, Biodiesel Blends (B6 – B20), ASTM D7467.

c) Biodiesel (B99.9/B100) formulated in accordance with the Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, ASTM D6751.

d) Kerosene formulated in accordance with the Standard Specification for Kerosine, ANSI/ASTM D3699.

e) Fuel Oil (Heating Oil) formulated in accordance with the Standard Specification for Fuel Oils, ASTM D396.

1.4 Requirements for the installation and use of these products are included in the Flammable and Combustible Liquids Code, ANSI/NFPA 30; the Motor Fuel Dispensing Facilities and Repair Garages Code, ANSI/NFPA 30A; and the National Electrical Code, ANSI/NFPA 70.

1.5 These requirements do not cover:

a) Oil burner pumps, which are evaluated under the Standard for Pumps for Oil-Burning Appliances, UL 343.

b) Pumps for engine-powered automotive equipment.

c) Pumps for marine use which are evaluated under the Standard for Mechanically and Electrically Operated Fuel Pumps for Marine Use, UL 1130.

d) Pumps for use in chemical, petrochemical, or petroleum processing plants; utility power plants; petroleum production facilities; pipeline pump stations; pipeline or marine terminals; or bulk plant distribution and related facilities.

e) Pumps used in mobile applications, such as on tank trucks, portable tanks, or portable containers mounted on vehicles.

f) Pumps rated more than 600 volts.

g) Pump assemblies also provided with a flammable liquid meter or electrically-operated shutoff valve, which are evaluated in accordance with the Standard for Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent (E0 – E85), UL 87A.

h) Pumps intended for use with gasoline and gasoline/ethanol blends which are evaluated in accordance with the Standard for Power Operated Pumps for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent (E0 – E85), UL 79A.

1.6 The pump assembly may be constructed such that it provides for the installation and use of a hose and hose nozzle valve.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component.

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

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

b) Is superseded by a requirement in this .

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

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

2.1.5 Electrical components, including motors and wiring, when incorporated by a manufacturer in an assembly with a pump, and including the means provided in the pump assembly for electrical connections, shall comply with the requirements for equipment for use in hazardous locations, Class I, Group D, National Electrical Code, ANSI/NFPA 70, Articles 500 and 501.

2.2 Units of measurement

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

2.3 Undated references

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

3 Glossary

3.1 For the purpose of this standard, the following definitions apply.

3.2 DIESEL/BIODIESEL BLENDS – Blended fuels composed of a diesel component and a biodiesel component. The numerical value corresponding to the biodiesel component determines the blend rating (such as B20 for 20% biodiesel and 80% diesel).

3.3 HAZARDOUS LOCATIONS – Locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixture.

3.4 INTRINSICALLY SAFE CIRCUIT – A circuit incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions include unintentional damage to any part of the equipment or wiring, insulation or other malfunction of electrical components, application of overvoltage, adjustment and maintenance operations, and other similar conditions.

3.5 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.

3.6 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of not more than 42.2 volts supplied by:

a) A battery;

b) A Class 2 transformer; or

c) A combination of a transformer and a fixed impedance that, as a unit, complies with the performance requirements for Class 2 transformers in accordance with the Standard for Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current is not a low-voltage circuit.

3.7 RAINPROOF ENCLOSURE –An enclosure that prevents the entrance of a beating rain to the extent that there is no wetting of electrical parts and no water enters a compartment housing field installed wiring.

3.8 SEALS, DYNAMIC – A seal that is subject to mechanical movement or other applied forces that result in movement or flexing of the seal under normal use conditions.

3.9 SEALS, STATIC – A seal that is not subject to mechanical movement or other applied forces other than compression forces that are applied during installation and maintained during normal use conditions.

CONSTRUCTION

4 Assembly

4.1 The construction of a pump shall be such that parts can be assembled in the intended manner after being dismantled to the extent needed for replacement of parts or for other maintenance or servicing.

4.2 When a pump requires the use of special pipe flanges, gaskets, bolts, or other special fittings or parts for making connections, such parts shall be furnished as part of the pump assembly.

4.3 A product shall be formed and assembled so that it has the strength and rigidity required to resist the abuses to which it is subjected without resulting in the risk of fire, electric shock, or injury to persons due to total or partial collapse with:

a) Resulting reduction of spacings;

b) Loosening or displacement of parts; or

c) Other defects.

4.4 A pump-motor assembly to be shipped from the manufacturer disassembled shall be provided with the marking described in 74.9.

5 Materials

5.1 Metallic materials

5.1.1 General

5.1.1.1 A metallic part, in contact with the fuels anticipated by these requirements, shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel or if it will impair the function of the device. See the Long Term Exposure Test, Section 41.

5.1.1.2 The exposed surfaces of metallic parts shall be resistant to atmospheric corrosion if this corrosion will lead to leakage of the fluid or if it will impair the function of the device. The material shall comply with the requirements in Atmospheric corrosion, 5.1.2.

5.1.1.3 Metallic parts in contact with the fuels anticipated by these requirements shall not be constructed of lead, or materials that are substantially lead. In addition, no coatings or platings containing lead shall be used, such as terne-plated steel.

5.1.1.4 With reference to the above requirements, metallic parts include metallic materials used to form fluid confining parts as well as metallic coatings or plating that may be applied to a base material.

5.1.2 Atmospheric corrosion

5.1.2.1 Metallic materials used for fluid confining parts shall be resistant to atmospheric corrosion. In addition, metallic materials that are required to operate to address safety (e.g. thermal links on shear valves) shall be resistant to atmospheric corrosion. Ferrous materials of the thickness specified in the following items are acceptable for the preceding when uncoated:

a) A casting having a wall thickness of not less than 1/4 inch (6.4 mm) if shown by production test to be free of leakage;

b) Standard pipe and fittings conforming to the Standard for Welded and Seamless Wrought Steel Pipe, ANSI/ASME B36.10M; and

c) Fabricated sheet steel parts having a minimum wall thickness of 0.093 inch (2.36 mm).

5.1.2.2 A protective coating shall provide resistance against atmospheric corrosion to a degree not less than that provided by the protective coatings specified in 5.1.2.3.

5.1.2.3 Cadmium plating shall not be less than 0.0003 inch (0.008 mm) thick, and zinc plating shall not be less than 0.0005 inch (0.013 mm) thick, except on parts where threads constitute the major portion of the area in which case the cadmium or zinc plating shall not be less than 0.00015 inch (0.0038 mm) thick. Metallic parts are considered to comply with 5.1.2.1 when they are protected against atmospheric corrosion by:

a) Hot dipped, mill galvanized sheet steel complying with the coating designation G90 in Table I of the Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron-Alloy Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M; or

b) Coatings which have been determined to be equivalent to G90 under the requirements of the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

5.1.2.4 A metallic material other than as described in 5.1.2.1 – 5.1.2.3 shall be painted or protected in a manner that has been determined to be equivalent.

5.2 Nonmetallic materials

5.2.1 General

5.2.1.1 A nonmetallic part in contact with the fuels anticipated by these requirements, shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel, or if it will impair the function of the device.

5.2.1.2 Gaskets or seals shall be designated as dynamic and/or static seals. See 3.8 and 3.9 respectively. If the type of seal cannot be determined, then the material shall be treated as both a static and a dynamic seal.

5.2.1.3 Gaskets and seals shall comply with the requirements as d in Nonmetallic materials – material level, 5.2.2 and Materials – system level, 5.3.

5.2.1.4 Nonmetallic materials in contact with the fuels anticipated by these requirements shall not be constructed of the following:

a) Polysulfide rubber;

b) Ethylene propylene diene monomer (EPDM) rubber;

c) Methyl-Methacrylate;

d) Polyvinyl Chloride (PVC);

e) Nylon 6/6; or

f) Polyurethane.

5.2.1.5 The reliability of a nonmetallic, pneumatic pressure confining part shall be determined for each application. Among the factors to be taken into consideration with the reliability of a nonmetallic material are:

a) Mechanical strength;

b) Resistance to impact;

c) Resistance to distortion and creeping at temperature and pressures to which the material is subjected under conditions of intended use; and

d) Dimensional stability.

Compliance with this requirement is determined by the tests of Sections 52, 68, 69, and 70.

5.2.2 Nonmetallic materials – material level

5.2.2.1 Static seals

5.2.2.1.1 Static seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157, modified as indicated in 5.2.2.1.2 – 5.2.2.1.4. If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

5.2.2.1.2 A static seal shall be constructed of a material that is acceptable in accordance with the scope of Standard for Gaskets and Seals, UL 157.

5.2.2.1.3 Static seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SA; and

c) For all materials, the average volume change shall not exceed 40% swell (increase in volume) or 1% shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10%. For coated fabrics, alternate limits can be used with the average volume change not exceeding 60% swell or 5% shrinkage, and the weight loss shall not exceed 20%. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

5.2.2.1.4 Static seals shall be subjected to the Compression Set Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours.

b) The samples shall be immersed, at room temperature, in the test fluids (see item c) while compressed for the entire test duration. No oven conditioning is required.

c) The applicable test fluids shall be as described in Supplement SA.

d) The recovery period shall consist of removing the sample from the compression device and immersing it in the applicable test fluid for 30 minutes at room temperature. The sample shall not be allowed to dry out due to exposure to air. The 30-minute immersion should use the same fluid as the test fluid for each sample.

e) For all materials, the average compressions set is calculated and shall not exceed 35 percent. For coated fabrics, alternate limits can be used with the average compression set not exceeding 70%.

Exception: This requirement does not apply to composite gasket materials as defined in accordance with the Standard for Gaskets and Seals, UL 157.

5.2.2.2 Dynamic seals

5.2.2.2.1 Dynamic seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157, modified as indicated in 5.2.2.2.2 – 5.2.2.2.4. If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

5.2.2.2.2 A dynamic seal shall be constructed of a material that is acceptable in accordance with the scope of the Standard for Gaskets and Seals, UL 157.

5.2.2.2.3 Dynamic seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SA; and

c) For all materials, the average volume change for a gasket or seal material shall not exceed 40% swell (increase in volume) or 1% shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10%. For coated fabrics, alternate limits can be used with the average volume change not exceeding 60% swell or 5% shrinkage, and the weight loss shall not exceed 20%. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

5.2.2.2.4 Dynamic seals shall be subjected to the Tensile Strength and Elongation Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SA; and

c) For all materials, the average tensile strength and the average elongation of materials shall not be less than 60 percent of the as-received values. For coated fabrics, alternate limits can be used with the average tensile strength and the average elongation not less than 30% of the as-received values.

5.3 Materials – system level

5.3.1 For all materials, gaskets and seals that have been shown to comply with the applicable requirements for static seals in the Standard for Gaskets and Seals, UL 157, or with the requirements under material level tests shall be subjected to the system level tests for the applicable component after the Long Term Exposure Test, Section 41. Static seals shall be provided in accordance with 41.2.4.

5.4 Casting impregnation materials

5.4.1 Material level

5.4.1.1 Casting impregnation materials shall be evaluated at the material level in accordance with the requirements in the of Investigation for Dispensing Devices For Diesel Fuel, Biodiesel Fuel,

Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosene, and Fuel Oil, UL 87B.

5.4.2 System level

5.4.2.1 The casting impregnation material, applied as intended to a casting, shall comply with the Long Term Exposure Test, Section 41. The casting shall not show indications of porosity leakage at any point during or after this test.

5.5 Internal parts

5.5.1 Nonmetallic parts located internally to a fluid confining part, degradation of which would not directly result in leakage, are not required to comply with Nonmetallic materials, 5.2. The part shall be tested in accordance with 5.5.2.

5.5.2 Internal nonmetallic parts shall be tested during the Long Term Exposure Test, Section 41. During this test, the part shall not degrade to the extent that visible particles can be observed in the drained fluid.

6 Bodies, Covers, and Heads

6.1 A pump body assembly shall withstand the Deformation Test, High Pressure Leakage Test, and Hydrostatic Strength Test requirements specified in 46, 42, and 44, respectively. These requirements do not apply to body sections of submersible type pumps intended to be immersed in the liquid.

6.2 Plugs and other parts, other than cap screws and bolts threaded into noncorrosion-resistant ferrous parts of the pump, shall be of corrosion-resistant metal or provided with a protective coating when they are required to be removed for adjustment, repair, or other care of the pump.

6.3 A plug, cap, or other part threaded into or on the pump body shall engage with at least four full threads.

6.4 A bolt or a screw hole shall not extend through the outer walls of a pump body into a liquid-handling section.

7 Drive-Shaft Seals

7.1 A stuffing box or a seal shall comply with the requirements specified in the Endurance Test – Pumps, Section 43.

7.2 An adjustable stuffing box, when guarded or not accessible, or when clearly visible to the operator, shall be provided with a spring-loaded follower gland or the equivalent.

7.3 An automatic spring take-up for a gland shall employ a spring made of corrosion resistant material or coated to retard corrosion.

7.4 The physical characteristics of a take-up spring shall be such that it advances the gland through not less than one-half its possible travel from its initial setting with the spring compressed.

7.5 The stuffing-box recess shall be such that packing material does not come into contact with screw threads.

8 Diaphragms

8.1 A metal part coming in contact with a diaphragm shall have no sharp edges, burrs, projections, and surfaces that are capable of chafing or abrading the diaphragm.

8.2 A pump, in which a flexible diaphragm, bellows, or similar construction constitutes the only fluid seal, shall be constructed such that the atmospheric side of the diaphragm or bellows is enclosed in a casing construction to reduce external leakage in the event of a diaphragm or bellows rupture, or shall have provisions for connection of a vent pipe or tubing intended to be routed to the outdoors or other location determined to be equivalent. See 74.8.

9 Springs

9.1 An operating spring shall be guided and arranged to reduce binding, buckling, or other interference with its free movement. When required, ends of a spring shall be closed and squared.

9.2 A spring employed in a pump to reduce the risk of leakage, shall:

a) Be protected against abrasion and corrosion and

b) Demonstrate no loss in strength following subjection to a compression force of three times that exerted by the spring in any position of its intended function.

9.3 In reference to 9.2(a), springs that are exposed to the fuels anticipated by these requirements shall comply with the applicable material requirements from Materials, Section 5. Springs not exposed to fuels, but exposed to the environment, shall comply with the atmospheric corrosion requirements in 5.1.2.

10 Floats

10.1 A float constructed to actuate a mechanism shall have a buoyancy not less than 50 percent greater than that required to operate the mechanism. See the Float Buoyancy Test, Section 51.

10.2 A hollow float shall withstand an external crushing pressure of not less than 35 psig (240 kPa). See the Float Crushing Test, Section 54.

10.3 A cork float shall be provided with a coating that is resistant to the action of the liquid with which it is in contact. Compliance of the coating is verified by the Long term Exposure Test, Section 41.

10.4 A float shall be secured to its corresponding lever, rod, or other part of the mechanism by a method that prevents the float from becoming detached under its intended conditions of operation.

10.5 A float constructed of nonmetallic materials shall comply with the requirements of the

a) Float Buoyancy Test, Section 51;

b) Dimensional Stability of Floats Test, Section 52; and

c) Weight Change of Floats Test, Section 53.

11 Air Separators

11.1 Air separators that are provided as an integral part of a pump assembly shall be provided with floats that comply with the requirements of Floats, Section 10.

11.2 The valve mechanism operated by the float shall be subjected to the Endurance Test for Air Separators, Section 48. When the valve mechanism closes a vent to atmosphere, it shall also be subjected to the High Pressure Leakage Test, Section 42.

12 Strainers

12.1 A strainer integral with or provided as part of a pump assembly shall comply with the applicable requirements in the of Investigation for Strainers for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosene, and Fuel Oil, UL 331A. The additional requirements of 12.2 – 12.6 apply.

12.2 A strainer shall enable the removal of foreign matter (sediment or dirt) without depositing the foreign matter in the outlet side of the strainer when the screen or filter element is removed for cleaning.

12.3 A strainer shall be installed and located so that removal and replacement of the strainer element is accomplished without breaking liquid lines or disturbing any part of the pump assembly. The location shall provide for the collection and removal of any spillage.

12.4 When provided, a drain opening shall be closed by a pipe plug not smaller than 1/4 inch pipe size (ANSI B36.10M). A pet cock or valve shall not be provided for drainage purposes. The materials shall comply with Materials, Section 5.

12.5 The force necessary to open a strainer shall not permanently distort the assembly or piping to which the strainer is attached.

12.6 Filter elements do not need to be evaluated for fluid compatibility.

13 Outlet Pressure Regulation

13.1 A pump assembly for use with or in dispensing devices intended to dispense the fuels anticipated by this shall incorporate means for the prevention of or the relief of pressures developed by the pump in excess of the maximum discharge pressure of 50 psig (345 kPa) or the marked maximum discharge pressure rating, whichever is less. See Blocked Outlet Test, Section 49.

13.2 To comply with the requirements in 13.1, a pump assembly may be equipped with:

a) A bypass valve connected between the discharge and suction ports;

b) A relief valve arranged to be connected between the discharge side and the supply tank through a separate return line. When the relief valve is not provided as part of the pump, it shall be marked as indicated in 74.6;

c) A means to effect an automatic reduction in volumetric capacity upon an increase in pressure at the outlet; or

d) An energy input incapable, because of power or speed, of developing a discharge pressure in excess of the maximum discharge pressure.

13.3 After the valve or other means for pressure regulation has been adjusted in accordance with the requirements in 13.1, it shall:

a) Be capable of being sealed to discourage tampering;

b) Be located within the pump body and require tools for access; or

c) Be constructed so that the maximum adjustment obtainable does not result in a pressure in excess of the maximum discharge pressure under maximum output conditions.

14 Pressure Relief

14.1 A pump for use with or in dispensing devices intended to dispense the fuels anticipated by this shall incorporate means for the relief of pressures developed by thermal expansion of the fluid in excess of the maximum discharge pressure of 50 psig (345 kPa), or in excess of the marked maximum discharge pressure, whichever is less. Thermal expansion pressure shall anticipate a temperature rise of 28° C (50°F) in an ambient temperature of 24°C (75°F). See the Pressure Relief Test, Section 50.

14.2 To comply with the requirements in 14.1, a pump assembly may be equipped with:

a) A bypass valve connected between the discharge and suction ports and

b) A relief valve arranged to be connected between the discharge side and the supply tank through a separate return line. When the relief valve is not provided as part of the pump, it shall be marked as indicated in 74.6.

14.3 After the valve or other means for pressure relief has been adjusted in accordance with the requirements in 14.1, it shall be:

a) Capable of being sealed to discourage tampering;

b) Located within the pump body and require the use of tools for access; or

c) Constructed so that the maximum adjustment obtainable does not result in a pressure in excess of the maximum discharge pressure.

15 Mounting and Base

15.1 A pump shall be provided with supporting and mounting means independent of liquid-handling pipe connections. A mounting arrangement shall permit anchoring of the pump by bolts or cap screws.

15.2 When a base is furnished as part of a pump assembly, it shall be arranged to permit attachment and alignment of mounted parts and for anchoring to a mounting surface by cap screws or bolts.

16 Guards

16.1 A gear, belt, pulley, or other rotating part shall be enclosed in a metal guard or the pump assembly shall be furnished with an enclosure.

17 Piping and Fittings

17.1 Pipe threads shall be in accordance with the Standard for Pipe Threads, General Purpose (Inch) ANSI/ASME B1.20.1.

17.2 Flanges of flange-type pumps shall comply with the appropriate American National Standard for pipe flanges and flanged fittings covering the material from which they are made, or such flanges and flanged fittings shall comply with all of the following tests as complete assemblies forming part of the pump:

a) High Pressure Leakage Test, Section 42;

b) Hydrostatic Strength Test, Section 44;

c) Retention Test for Screws and Bolts, Section 45;

d) Deformation Test, Section 46; and

e) 10-Day Moist Ammonia-Air Stress Cracking Test, Section 55.

17.3 An opening threaded for attachment to pipe shall be constructed so that a pipe threaded two threads beyond standard construction (for the size in question) is capable of being threaded into the opening without distorting any part of the fitting.

17.4 A male thread for attachment to pipe fittings shall have no shoulder within the distance specified in Table 17.1, from the beginning of the thread, including any chamfer, nor shall any shoulder prevent an additional turn being made within this distance as determined by assembling the part into a fitting within a tolerance of plus or minus one thread.

Table 17.1
Minimum shoulder distance from beginning of thread

Pipe size, ANSI B36.10M, nominal inches	Shoulder distance, inches	(mm)
1/8	3/8	9.5
1/4, 3/8	9/16	14.3
1/2, 3/4	3/4	19.1
1	15/16	23.8
1-1/4	31/32	24.6
1-1/2	1	25.4
2	1-1/32	26.2
1-1/2	1-33/64	38.5
3	1-37/64	40.1

17.5 A threaded pipe connection shall be made with litharge and glycerine cement, shellac, shellac and inert powder filler, or a suitable pipe-joint sealing compound that is not alcohol based.

17.6 ASTM Schedule 40 metallic pipe shall be used, and the metallic materials shall comply with Materials, Section 5. A union, when used, shall be of the ground-joint type or a part that has been determined to be equivalent.

17.7 Tubing may be used where it is protected by its location in the pump assembly or by its intended installation location. Tubing and tube fittings shall be metallic and all metallic materials shall comply with Materials, Section 5.

17.8 Tubing shall have a minimum wall thickness in accordance with Table 17.2 in any configuration that is used.

Table 17.2
Wall thickness for tubing

Outside diameter,		Minimum wall thickness,	
inch	(mm)	inch[a]	(mm)[a]
1/8	3.17	0.028	0.71
1/4	6.35	0.028	0.71
5/16	7.94	0.028	0.71
3/8	9.53	0.028	0.71
1/2	12.7	0.0315	0.80

[a] Nominal wall thickness of tubing is required to be greater than the thickness indicated to maintain the minimum wall thickness.

18 Hose Nozzle Valve, Hose, and Coupling

18.1 A pump assembly for use with service-station type hose-nozzle valves may be furnished without a hose-nozzle valve when the assembly is marked as specified in 74.4. If the hose nozzle valve is provided, the hose nozzle valve shall be in accordance with the of Investigation for Hose Nozzle Valves for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosene, and Fuel Oil, UL 2586B.

18.2 When a hose assembly, consisting of hose and couplings, is supplied with the pump assembly, it shall comply with the of Investigation for Hose and Hose Assemblies for Dispensing Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends With Nominal Biodiesel Concentrations Up To 20 Percent (B20), Kerosene, and Fuel Oil, UL 330A.

19 Conduit Seals

19.1 A factory-installed conduit seal incorporated as part of the product shall comply with the requirements of the High Pressure Leakage Test, Section 42; the Leakage of Wire Seal Test, Section 47; and the Hydrostatic Strength Test, Section 44.

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

a) Provide a tight fit;

b) Neither soften nor crack under service conditions;

c) Be resistant to the solvent action of the liquids and vapors to which it is capable of being exposed – see the Tests on Sealing Compounds, Section 56;

d) Be resistant to moisture and aging; and

e) Have a depth equal to the inside diameter of the conduit or 5/8 inch (15.9 mm), whichever is greater.

The sealing compound used in a conduit seal shall not flow or creep at the operating temperature of the device. Sealing compounds that soften with the application of heat shall have a softening point of not less than 94°C (200°F) when used adjacent to motors having Class A (Class 105) insulation and not less than 113°C (236°F) when used adjacent to motors having Class B (Class 130) insulation. The softening point is to be determined in accordance with the Standard Test Method for Softening Point by Ring-and-Ball Apparatus, ASTM E28.

19.3 When a nipple is used to retain the sealing compound for lead wires, the depth of the seal shall not be less than the internal diameter of the nipple or 5/8 inch (15.9 mm), whichever is greater. Depending on the compound, the size of the lead wires, and the construction of the sealing well, a greater depth of sealing compound shall be used as required to form a tight seal. Means shall be provided in the nipple to anchor the sealing compound.

20 Electrical Equipment

20.1 Electrical conduit to be immersed in the liquid to be handled shall be of the rigid, seamless, metallic type or other material that has been determined to be equivalent.

20.2 Electrical equipment and wiring shall be arranged so that the liquid does not drip or drain on them during the intended care and usage of the pump assembly.

20.3 Wiring shall be in threaded rigid metal conduit, threaded steel intermediate metal conduit, or Type MI cable with termination fittings that comply with the requirements for Class I, Group D equipment for use in hazardous locations specified in the National Electrical Code, ANSI/NFPA 70. All boxes, fittings, and joints shall be threaded for connection to conduit or cable terminations in compliance with the requirements in Class I, Group D equipment for use in hazardous locations. At least five full threads shall engage in each threaded joint.

Exception: The housing may be considered the electrical enclosure for intrinsically safe circuit wiring.

20.4 One end of a wireway between two parts that are factory-attached to an assembly may be secured to one of the parts by means of straight threads and, where necessary for security, with a locknut when the other end of the wireway is secured to the other part by tapered threads.

20.5 A compartment enclosing a switch or other part that is capable of producing arcs shall be sealed from any adjacent compartment in which field connections are to be made.

20.6 The ends of all conduit lengths, including nipples, shall be chamfered after threading to remove burrs or sharp edges.

20.7 For a vapor-tight fit, the sheath of shielded or multiconductor cables shall be split to enable the seal materials to be poured around the individual conductors.

Exception: Shielded or multiconductor cables that are evaluated in accordance with the Leakage of Wire Seal Test, Section 47, for the cable are not required to be split.

20.8 A terminal box threaded to conduit enclosing wiring sealed against the entry of water, petroleum products, or vapor shall not be subject to turning or require removal to accommodate replacement or extraction of parts for maintenance, servicing, or to facilitate the connection of field-installed piping or conduit.

20.9 Upper ends of conduit subject to immersion or to entry of water, liquids, or vapors shall be sealed in the area between the conduit inside diameter and the enclosed wiring. Sealing shall be by means of litharge and glycerine, or with a nonmetallic material which has been successfully evaluated for use in this application. See Tests on Sealing Compounds, Section 56.

20.10 Threaded joints for conduit shall provide for five full-thread engagement. Threads subject to turning during installation or use shall be coated with litharge and glycerine. Threads not subject to turning during installation or use and subject to immersion in the fluids anticipated by these requirements shall be coated with litharge and glycerine or a suitable pipe-joint sealing compound that is not alcohol based. Threaded joints in a coupling used to join lengths of conduit immersed in petroleum products shall be

prevented from turning by leak-tight welding or brazing at the conduit and outside surfaces of couplings or by coating all threads with litharge and glycerine.

20.11 Wiring for motor or other leads subject to accidental immersion in petroleum products shall be of gasoline-resistant wiring material conforming with the construction, performance, and marking requirements in the Standard for Thermoset-Insulated Wires and Cables, UL 44, or the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

20.12 Grounding of motors and other electrical components and wiring shall be provided in accordance with the provisions of the National Electrical Code, ANSI/NFPA 70.

20.13 An outlet box or enclosure shall have no unplugged openings other than those to which conduit is always connected when the pump assembly is installed.

20.14 A pump assembly intended for use with a dispensing device that is to be connected to the branch circuit shall not be constructed in such a manner that is required that the outlet box of the product be moved in order to care for the device.

20.15 The size of a junction box in which field installed conductors are to be connected by splicing shall not be less than that specified in Table 20.1. A conductor passing through the box is counted as one conductor, and each conductor terminating in the box is also counted as one conductor. A field-furnished conductor for pump motor circuits shall not be smaller than 14 AWG (2.1 mm^2). A field-furnished conductor for a reset motor, signaling, or other circuit rated less than 5 amperes shall not be smaller than 18 AWG (0.8 mm^2) when the wire size is marked on the installation wiring diagram.

20.16 The size of a junction box in which field installed conductors are to be connected to factory installed terminal strips shall be determined by Table 20.1 as the summation of the volumes required for each field furnished conductor plus the volume utilized by the factory installed wiring and terminal block.

Table 20.1
Size of junction boxes

Size of conductor,		Free space within box for each conductor			
		Box with hubs,		Box without hubs,	
AWG	(mm^2)	cubic inches	(cm^3)	cubic inches	(cm^3)
16 or smaller	1.3 or less	1.3	21.3	1.5	24.6
14	2.1	1.8	29.5	2.0	32.8
12	3.3	2.0	32.8	2.25	36.9
10	5.3	2.2	36.1	2.5	41.0
8	8.4	2.7	44.2	3.0	49.2

20.17 When it is required that supply connections be made directly to a motor, the terminal compartment on the motor shall comply with the requirements for terminal compartments in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

21 Supply Connections

21.1 A permanently-connected product shall have provision for connection to a wiring system in accordance with the National Electrical Code, ANSI/NFPA 70.

21.2 A terminal box or compartment in which power-supply connections to a permanently-connected product are to be made shall be located in such a manner that the connections are readily accessible for inspection after the product is installed as intended.

21.3 A terminal box or compartment intended for connection of a supply raceway shall be attached to the product so as to be prevented from turning.

21.4 A permanently-connected product shall be provided with wiring terminals for the connection of conductors having an ampacity:

a) Not less than 125 percent of the full load motor-current rating of horsepower rated motors;

b) Not less than 100 percent of the ampere ratings of all other loads; or

c) Both (a) and (b); or

the product shall be provided with leads for such connection. See 21.8.

21.5 A field-wiring terminal is a terminal to which a wire is connected in the field, unless the wire, and a means of making the connection – a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, or similar parts – to the terminal, are provided as a part of the product.

21.6 Wiring terminals for the supply conductors – See Grounding, Section 27, for termination of the grounding conductor – shall be provided with a pressure wire connector securely fastened in place – for example, firmly bolted or held by a screw.

Exception No. 1: A soldering lug may be used.

Exception No. 2: A wire binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor when upturned lugs or parts that have been determined to be equivalent are provided to hold the wire in place.

21.7 A wiring terminal shall be prevented from turning.

21.8 A lead inside an outlet box or wiring compartment shall not be smaller than 18 AWG (0.82 mm^2), and rated for the maximum operating voltage of the pump assembly. The free length of the lead shall be 6 inches (150 mm) or more when the lead is intended for field connection to an external circuit.

Exception No. 1: A lead that is less than 6 inches long complies with the intent of this requirement when it is evident that the use of a longer lead is capable of resulting in a risk of fire or electric shock.

Exception No. 2: Factory wiring terminating at a terminal strip shall also be minimum 18 AWG (0.82 mm^2) unless arranged or guarded to protect from damage during field wiring.

21.9 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

Exception No. 1: A No. 8 screw may be used at a terminal when it is intended only for the connection of a 14 AWG (2.1 mm^2) conductor.

Exception No. 2: A No. 6 screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm^2) conductor. See 21.13.

21.10 The smallest conductor that is specified in the National Electrical Code, ANSI/NFPA 70, for use in branch-circuit wiring is 14 AWG (2.1 mm^2). Therefore, the smallest conductor that is anticipated at a terminal for connection of a power-supply wire is 14 AWG.

21.11 A wire-binding screw shall thread into metal.

21.12 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick and shall not have less than two full threads in the metal.

Exception No. 1: A terminal plate less than 0.050 inch thick but not less than 0.030 inch (0.76 mm) thick may be used when the tapped threads result in a secure connection in which the threads do not strip upon the application of a 20 pound-inch (2.26 N·m) tightening torque.

Exception No. 2: A terminal plate formed from stock not less than 0.050 inch thick may have the metal extruded at the tapped hole to provide two full threads.

21.13 A terminal plate shall incorporate upturned lugs or a cupped washer, and shall be capable of retaining a supply connector of the size specified in 21.4 under the head of the screw or washer.

21.14 A permanently-connected product rated 125 volts or less, or 125/250 volts (3-wire) or less, and employing a single-pole switch or overcurrent-protective device other than an automatic control without a marked "off" position shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The terminal or lead to be connected to the grounded supply conductor shall be the one to which no switch or overcurrent-protective device of the single-pole type, other than an automatic control without a marked "off" position, is connected.

21.15 A terminal intended for the connection of a grounded supply conductor (neutral) shall be of or plated with metal that is substantially white in color and shall be readily distinguishable from the other terminals; or proper identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

21.16 Conductors intended for field connection to a grounded supply conductor shall be identified (finished a white or gray color) or the intended wiring connections shall be clearly indicated in some other manner, such as on an attached wiring diagram. All other current-carrying conductors shall be finished in colors other than white, gray, or green with or without one or more yellow stripes.

21.17 Conductors intended for field connection to a 120-volt branch circuit protective device shall be provided and arranged such that an individual grounded supply conductor is provided for each ungrounded supply conductor.

21.18 Supply leads that are subject to handling during installation or routine maintenance of the product shall be capable of withstanding a pulling force as described in the Conductor Secureness Test, Section 65.

Exception: This requirement does not apply to leads that are integral with components such as motors where the leads have been subjected to this test during the investigation of the component.

22 Current-Carrying Parts

22.1 A current-carrying part shall be made of silver, copper, a copper alloy, or other similar metal.

22.2 Iron or steel shall not be used as a current-carrying part.

Exception No. 1: Iron or steel provided with a corrosion-resistant coating may be used for a current-carrying part:

a) When it complies with the requirements of Atmospheric corrosion, 5.1.2 or

b) Within a motor or associated governor.

Exception No. 2: The requirement does not apply to stainless steel.

23 Insulating Material

23.1 A material that is used for the direct support of an uninsulated live part shall comply with the Relative Thermal Index (RTI), Hot Wire Ignition (HWI), High-Current Arc Resistance (HAI), and Comparative Tracking Index (CTI) values indicated in Table 23.1. A material is in direct support of an uninsulated live part when it is in direct physical contact with the uninsulated live part, or when it serves to physically support or maintain the relative position of the uninsulated live part.

Exception: A generic material provided in the thickness indicated in Table 23.2 complies with Table 23.1 without additional evaluation.

Table 23.1
Minimum material characteristics for the direct support of uninsulated live parts

Flame class	RTI Electrical	Maximum performance level category (PLC)		
		HWI[b,c]	HAI[d,e]	CTI[f,g,h]
HB	a	2	1	3
V-2, VTM-2	a	2	2	3
V-1, VTM-1	a	3	2	3
V-O, VTM-0	a	4	3	3

Relative Thermal Index (RTI)
[a] The electrical Relative Thermal Index (RTI) value of a material is to be determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, by test or by use of the generic RTI table. This material characteristic is dependent upon the minimum thickness at which the material is being used. The RTI shall not be exceeded during the Temperature Test, Section 60.

Hot Wire Ignition (HWI)
[b] The Hot Wire Ignition (HWI) value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a HWI value, the material is evaluated as in footnote c.
[c] A material without an HWI Performance Level Category (PLC) value or with a HWI PLC value greater (worse) than the value required by Table 23.1 shall be subjected to the end-product Abnormal Overload Test or the Glow Wire End-Product Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Table 23.1 Continued on Next Page

Table 23.1 Continued

Flame class	RTI Electrical	Maximum performance level category (PLC)		
		HWI[b,c]	HAI[d,e]	CTI[f,g,h]

High Current Arc Resistance to Ignition (HAI)

[d] The HAI value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a HAI value, the material is evaluated as in footnote e.

[e] A material without an HAI PLC value or with an HAI PLC value greater (worse) than the value required by Table 23.1 shall be subjected to the end-product Arc Resistance Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Comparative Tracking Index (CTI)

[f] The Comparative Tracking Index (CTI) PLC value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is not dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a CTI value, the material is evaluated as having the same CTI value found for the greater thickness. The CTI value applies to insulating materials used in pollution degree 3 environments for voltages of 600 V or less. For equipment where pollution degree 1 or 2 is maintained, an insulating material shall have a CTI PLC of 4 or less. For equipment rated 601 – 1500 volts, see footnote h.

[g] A material without a CTI PLC value or with a CTI PLC value greater (worse) than the value required by Table 23.1 shall have a proof tracking index of 175 when used in pollution degree 3 environment or a proof tracking index of 100 when used in pollution degree 1 or 2 environment as determined by the end-product Proof Tracking Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[h] For equipment rated 601 – 1500 volts, the insulating material shall not track beyond one inch in less than 60 minutes using the time to track method of the Inclined Plane Tracking Test specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. The voltage for the Inclined Plane Tracking Test shall not be less than the rated voltage of the equipment.

Table 23.2
Generic materials for direct support of uninsulated live parts

Generic material	Thickness, inch	Thickness, (mm)	RTI, °C
Diallyl phthalate	0.028	0.71	105
Epoxy	0.028	0.71	105
Melamine	0.028	0.71	130
Melamine-phenolic	0.028	0.71	130
Phenolic	0.028	0.71	150
Unfilled nylon	0.028	0.71	105
Unfilled polycarbonate	0.028	0.71	105
Urea formaldehyde	0.028	0.71	100
Ceramic, porcelain, and slate	No limit		No limit
Berylium oxide	No limit		No limit

NOTE – Each material shall be used within its minimum thickness and its Relative Thermal Index (RTI) value shall not be exceeded during the Temperature Test, Section 60.

23.2 Vulcanized fiber is capable of being used for insulating bushings, washers, separators, and barriers. However, vulcanized fiber shall not be used as the sole support for uninsulated live parts where shrinkage, current leakage, or warping results in a risk of fire or electric shock.

23.3 Insulating material, including barriers between parts of opposite polarity and material that is capable of being subjected to the influence of the arc formed by the operating of a switch, shall be investigated for use in this application.

23.4 A printed-wiring board for which loosening of the bond between the conductor and base material results in contact between uninsulated primary circuit parts shall comply with the applicable requirements in the Standard for Printed-Wiring Boards, UL 796.

24 Internal Wiring

24.1 Mechanical protection

24.1.1 Wiring and connections between parts of a product shall be protected or enclosed.

24.1.2 Wires within an enclosure, a compartment, a raceway, or a similar device shall be routed or otherwise protected so that damage to conductor insulation does not result from contact with any rough, sharp, or moving part.

24.1.3 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces to prevent abrasion of the insulation.

24.1.4 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of a product.

24.2 Types of wire

24.2.1 Except for intrinsically safe circuits rated not more than 30 volts AC (42.4 volts peak), internal wiring shall consist of wires of a type or types that are rated for the application when evaluated with respect to the temperature, ampacity, and voltage to which the wiring is subjected and with respect to exposure to oil, grease, or other conditions of service to which it is subjected.

24.2.2 Thermoplastic-insulated wire employed for internal wiring shall be standard building wire or appliance wiring material that has been evaluated for the purpose.

24.2.3 Gasoline-resistant wire may be exposed to gasoline vapor (not liquid gasoline) at temperatures within the limits of the temperature rating of the wire type.

24.2.4 A conductor having solid neoprene insulation or other material that has been determined to have equivalent resistance to gasoline vapor may be used for internal wiring and as leads for components, such as motors, ballasts, solenoid valves, or similar items, when it has a temperature rating consistent with its use.

24.2.5 Regarding the requirements specified in 24.2.4, appliance wiring material having 90°C (194°F) solid neoprene insulation may be used for internal wiring not exposed to fluid when the insulation is at least 3/64 inch (1.2 mm) thick for 12 and 14 AWG (3.3 and 2.1 mm^2) sizes and at least 1/32 inch (0.82 mm) thick for 16 and 18 AWG (1.3 and 0.82 mm^2) sizes. A braid covering is not required to be provided. Wire having 1/32 inch thick insulation shall not be used in discharge devices rated in excess of 300 volts.

24.2.6 When wiring is not routed near heat-producing components such as resistors, coils ballasts, or similar items, the wire size shall be as specified in Table 24.1. Wiring is applicable to both component leads and other wiring.

Exception No. 1: Leads furnished with a Class I, Group D motor are not required to comply with the requirements of Table 24.1.

Exception No. 2: Wiring may be:

a) Routed near heat-producing components or

b) Smaller than the sizes specified in Table 24.1.

when it complies with the requirements of the Temperature Test, Section 60.

Table 24.1
Wire size for circuit requirements

Wire size		Circuits not employing motors,	Circuits for motors,
AWG	(mm^2)	amperes	amperes
18	0.82	6	4.8
16	1.3	8	6.5
14	2.1	15	12.0
12	3.3	20	16.0

24.3 Splices and connections

24.3.1 Splices in wiring shall be located only in junction boxes or areas that have been determined to be equivalent.

24.3.2 Each splice and connection shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be mechanically secured before being soldered when breaking or loosening of the connection is capable of resulting in a risk of fire or electric shock.

24.3.3 The requirement in 24.3.2 necessitates the use of a lock washer or other means that has been determined to be equivalent to reduce the possibility of a wire-binding screw or a nut being loosened.

24.3.4 A splice shall be provided with insulation that has been determined to be equivalent to that of the wires involved when permanence of spacing between the splice and other metal parts is not maintained.

24.3.5 Insulated or uninsulated aluminum conductors used as internal wiring, such as for internal connection between current-carrying parts or as motor windings, shall be terminated by a method that has been determined to be appropriate for the combination of metals involved at the point of connection.

24.3.6 With reference to the requirements in 24.3.5, a wire-binding screw or a pressure wire connector used as a terminating device shall be rated for use with aluminum under the conditions involved – for example, temperature, heat cycling, vibration, and similar conditions.

24.3.7 Insulation consisting of:

a) Two layers of friction tape;

b) Two layers of thermoplastic tape; or

c) One layer of friction tape on top of one layer of rubber tape

may be used on a splice when the voltage involved is less than 250 volts. In determining when splice insulation consisting of coated-fabric, thermoplastic, or other type of tubing complies with the intent of this requirement, consideration shall be given to such factors as its dielectric properties, heat- and moisture-resistant characteristics, and similar features. Thermoplastic tape is not to be wrapped over a sharp edge.

24.3.8 When stranded internal wire is connected to a wire-binding screw, loose strands of wire shall be positively prevented from contacting an uninsulated live part that is not always of the same polarity as the wire and from contacting a dead metal part. This shall be accomplished:

a) By use of a pressure terminal connector, soldering lug, or crimped eyelet;

b) By soldering all strands of the wire together; or

c) By other means that have been determined to be equivalent.

24.3.9 A nominal 0.110 inch (2.8 mm), 0.125 inch (3.2 mm), 0.187 inch (4.75 mm), 0.205 inch (5.2 mm), or 0.250 inch (6.35 mm) wide quick-connect terminal shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310. Other sizes shall be investigated with respect to:

a) Crimp pullout;

b) Engagement-disengagement forces of the connector and tab; and

c) Temperature rises.

All tests shall be conducted in accordance with UL 310.

25 Separation of Circuits

25.1 Conductors of circuits operating at different potentials shall be reliably separated from each other unless they are each provided with insulation rated for the highest potential involved.

25.2 An insulated conductor shall be reliably retained so that it is not capable of contacting an uninsulated live part of a circuit operating at a different potential.

25.3 In a compartment that is intended for the field installation of conductors and that contains provision for connection of Class 2 or Class 3 circuit conductors and Class 1 (power or lighting) circuit conductors, as defined in the National Electrical Code, ANSI/NFPA 70, a barrier shall be provided to separate the conductors of the different circuits, or the arrangement of the compartment shall be such that a minimum spacing of 1/4 inch (6.4 mm) is permanently maintained between the conductors of the different circuits, including the conductors to be field installed.

26 Capacitors

26.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that protects the plates against mechanical damage and that prevents the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall be of metal providing strength and protection not less than that of 0.020 inch (0.51 mm) thick uncoated steel. Sheet metal having a thickness less than 0.026 inch (0.66 mm) shall not be used.

Exception: The individual container of a capacitor that is made of sheet metal less than 0.020 inch thick or of material other than metal may be used when the capacitor is mounted in an enclosure that houses other parts of the product and when such housing is evaluated for the enclosure of live parts.

26.2 When a capacitor that is not a part of a capacitor motor or a capacitor-start motor is connected in a product that is intended to be automatically or remotely controlled so that malfunction or breakdown of the capacitor is capable of resulting in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the product to reduce the possibility of such a condition occurring.

26.3 A capacitor connected from one side of the line to the enclosure of a product shall have a capacitance rating of not more than 0.10 microfarad.

26.4 When a product employs a combination consisting of a rectifier and an electrolytic capacitor, a risk of fire, electric shock, or injury to persons shall not occur when either the rectifier or the capacitor is short-circuited.

26.5 Under both normal and abnormal conditions of use, a capacitor employing a liquid dielectric medium more flammable than askarel shall not expel the dielectric medium when tested in accordance with the applicable performance requirements in this standard.

26.6 When a product is constructed to be controlled by or operated in conjunction with a capacitor or a capacitor/transformer unit, such a capacitor or unit shall be supplied with the product. See 74.11.

27 Grounding

27.1 General

27.1.1 A product shall have provision for grounding. This requirement also applies to pneumatically-powered pump assemblies.

27.1.2 Means shall be provided so that connection to a field-installed equipment grounding conductor is capable of being made in the same junction box used for field-installed conductors.

27.1.3 Grounding means shall be in accordance with 27.1.4 – 27.1.7. All exposed dead-metal parts and all dead-metal parts within the enclosure that are exposed to contact during any user servicing operation and are capable of becoming energized shall be reliably connected to the means for grounding.

27.1.4 The equipment grounding terminal or lead at the point at which the power-supply wiring system is connected shall be used for grounding.

27.1.5 When a product is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

27.1.6 A terminal intended solely for the connection of an equipment-grounding conductor shall be capable of securing a conductor of the size required for the application. A connection device that depends on solder alone shall not be provided for connecting the equipment-grounding conductor. A push-in, screwless connector or quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections.

27.1.7 A wire-binding screw or pressure wire connector intended for the connection of an equipment grounding conductor shall be located so that it is not capable of being removed during servicing of the product.

27.1.8 With reference to the requirement in 27.1.3, the following dead-metal parts are not capable of becoming energized:

a) A small metal part, such as an adhesive-attached foil marking, a screw, a handle, and a similar item, that is:

1) On the exterior of the enclosure and separated from all electrical components by grounding metal or

2) Electrically isolated from all electrical components;

b) A panel, cover, or other metal part that is isolated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 1/32 inch (0.80 mm) thick and securely mounted in place;

Exception: A barrier or liner made from other materials or that is less than 1/32 inch thick may be used when it complies with the requirements for internal parts in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

c) A panel, cover, or other metal part that does not enclose uninsulated live parts and is electrically isolated from other electrical components; and

d) Metal parts such as cores and assembly screws of a relay or a solenoid that are positively separated from wiring and uninsulated live parts.

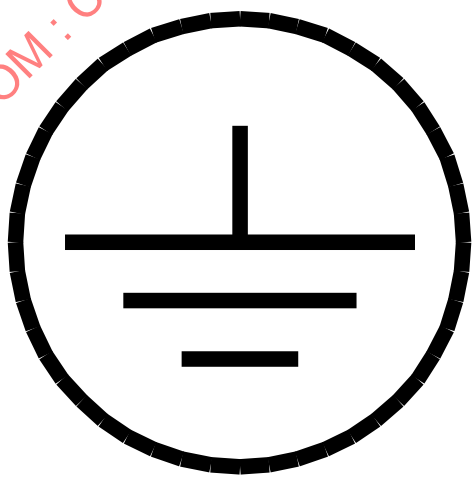
27.2 Grounding identification

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

27.2.2 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, or slotted, or both. A pressure wire connector intended for connection of an equipment-grounding conductor shall be plainly identified, such as by being marked “G," "GR," "Ground," "Grounding ," or by a similar designation, or by a marking on a wiring diagram provided on the product. The grounding symbol illustrated in Figure 27.1 used as an identifying means complies with the intent of this requirement; however, when used alone, the symbol shall be defined in the installation instructions provided with the product.

Figure 27.1

Grounding symbol



28 Motors

28.1 Construction

28.1.1 A motor intended for use in a Division 1 classified area shall comply with the requirements in the Standard for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations, UL

674. Motors for use in unclassified areas shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

28.1.2 A motor shall be successfully evaluated for the application and shall be capable of handling the maximum normal load of the product as described in 60.2.1 without creating a risk of fire, electric shock, or injury to persons.

28.1.3 A motor winding shall resist the absorption of moisture.

28.1.4 With reference to the requirement in 28.1.3, film-coated wire is not required to be additionally treated to prevent absorption of moisture. However, fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated to prevent moisture absorption.

28.1.5 Motors for electrically-operated pump assemblies intended to be used outdoors shall comply with the requirements of the Rain Test, Section 63. Pump assemblies complying with the Rain Test shall be marked in accordance with 74.7.

28.2 Overload protection

28.2.1 A motor for use in an unclassified area shall be provided with overload protection consisting of one of the following:

a) Thermal protection complying with the applicable requirements in either the Standard for Overheating Protection for Motors, UL 2111 or the Standard for Thermally Protected Motors, UL 1004-3.

Exception No. 1: For a product that includes a control as mentioned in 28.2.2, the duration of the temperature test and the endurance test described in UL 2111 or UL 1004-3, both under locked-rotor conditions, may be less than that specified; however, it shall not be less than the period of operation of the product intended by the manufacturer.

Exception No. 2: When the time required to operate a manually-reset protective device through 10 cycles of operation is longer than the time that the product is intended to be operated during each use, the number of operations of the device for the temperature test under locked-rotor conditions may be less than 10 cycles; however, it shall not be less than four cycles.

b) Impedance protection complying with the applicable requirements in either the Standard for Overheating Protection for Motors, UL 2111 or Standard for Impedance Protected Motors, UL 1004-2, when the motor is tested as used in the product under locked-rotor conditions.

c) Other protection that is shown by test to be equivalent to the protection mentioned in (a).

28.2.2 The control specified in Exception No. 1 to 28.2.1(a) is a control that positively and reliably limits the length of time the product can be operated – for example, a timer.

28.2.3 For a multispeed motor, the requirement in 28.2.1 applies to all speeds at which the motor is intended to operate.

28.2.4 When a requirement in this standard refers to the horsepower rating of a motor, and the motor is not rated in horsepower, the appropriate table of the National Electrical Code (NEC), ANSI/NFPA 70, that gives the relationships between horsepower and full-load currents for motors shall be used. For a universal motor, Table 430-248 of the NEC – the table applying to a single-phase, AC motor – shall be used when the product is marked for use only on alternating current; otherwise, Table 430-247 of the NEC – the table applying to DC motors – shall be used.

28.2.5 The functioning of a motor-protective device provided as part of a product shall not result in a risk of fire or injury to persons.

28.2.6 Overload devices employed for running-overload protection, other than those that are inherent in a motor, shall be located in at least one ungrounded conductor of a single-phase supply system, and in each ungrounded conductor of a 3-phase supply system.

28.2.7 Fuses employed for motor running-overload protection shall be located in each ungrounded conductor; and in the case of a 3-phase, 3-wire, AC motor, the fuses shall be located in each of the three phases.

28.3 Brushes and brush holders

28.3.1 A brush cap shall be recessed, enclosed, or otherwise protected from mechanical damage that occurs during the intended use of the product.

28.3.2 A brush cap that is accessible to the user without the removal of a guard or enclosure shall be provided with a positive means that prevents its disengagement from the brush-holder assembly. The use of screw threads on the brush cap as the only means of securing the brush cap to the brush-holder assembly is not a positive means.

28.3.3 A brush-holder assembly shall be constructed so that when a brush is worn out – that is, no longer capable of performing its function – the brush, spring, and other parts of the assembly are retained to the degree required to reduce the risk of:

a) Accessible dead metal parts becoming energized and

b) Live parts becoming accessible.

29 Overload- or Thermal-Protective Devices

29.1 An overload- or thermal-protective device shall have a current and voltage rating not less than the load that it controls.

29.2 When the current rating of a product is more than 40 amperes, and there are subdivided circuits within the product feeding two or more power-consuming components – motors or motor-control circuits – connected in parallel with each other across any pair of main-supply terminals or leads, overcurrent protection shall be provided as a part of the product for the conductors of each terminal circuit.

Exception: Additional overcurrent protection is not required as a part of the product for the conductors of the following subdivided circuits:

a) For each separate motor circuit supplied by insulated conductors having an ampacity at least one-third that of the protective device in the branch circuit to which the product shall be connected.

b) For each separate motor-control circuit supplied by insulated conductors having an ampacity at least one-fifth that of the protective device in the branch circuit to which the product shall be connected

29.3 A protective device such as a fuse, the functioning of which requires renewal or replacement, shall be in a readily accessible location. A protective device shall be wholly inaccessible from outside the product without opening a door or cover.

Exception: The operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts may project outside the enclosure.

29.4 A fuseholder shall be constructed and installed so that no uninsulated live part, other than the screw shell or clips, are exposed to contact by persons removing or replacing fuses. The screw shell of a plug-type fuseholder shall be connected toward the load.

30 Switches and Controls

30.1 A switch or other control device shall have a current and voltage rating not less than that of the load that it controls.

30.2 With reference to the requirement in 30.1, the current rating of a switch that controls an inductive load other than a motor, such as a transformer, shall not be less than twice the rated full-load current of the transformer, unless the switch has been investigated and found capable of handling the load.

30.3 A line-connected, manually-operated single-pole switch or an overcurrent (overload) protective device of the single-pole type, other than an automatic control without a marked "off" position, shall be connected to a terminal or lead intended for connection to an ungrounded conductor of the supply circuit.

30.4 A switch or other control shall be guarded or located so that it is not capable of being damaged during the intended use of the product.

30.5 Variable speed motor drives shall be evaluated in accordance with the requirements of the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1.

30.6 Variable-speed motor drives that use electronics that are intended to limit the maximum output pressure of the pump assembly shall be evaluated in accordance with the requirements of the Standard for Limit Controls, UL 353.

30.7 A failure in the electronics of the motor drive described in 30.6 during its intended operation is allowed when there is no loss of protective function of limiting the maximum output pressure of the pump.

30.8 A blocked outlet of a pump which does not usually experience such a condition shall be considered a fault condition when the product is evaluated in accordance with 30.6.

31 Spacings

31.1 All uninsulated live parts connected to circuits of different voltage ratings shall be spaced from each other as though they were parts of opposite polarity in accordance with the requirements in 31.3 and 31.4, and shall be evaluated on the basis of the highest voltage involved.

31.2 The spacing between uninsulated live parts of opposite polarity, and between such parts and dead metal that are capable of being grounded in service is not specified for parts located in low-voltage circuits.

31.3 The spacing between a field-wiring terminal and any other uninsulated live or dead metal part not of the same polarity shall not be less than the applicable value specified in Table 31.1. See 21.5 and 31.7.

Table 31.1
Spacings at field-wiring terminals

Potential involved, volts	Minimum spacings, inch (mm)					
	Between wiring terminals, through air or over surface		Between terminals and other uninsulated metal parts not always of the same polarity[a]			
			Over surface		Through air	
250 or less	1/4	6.4	1/4	6.4	1/4	6.4
More than 250	1/2[b]	12.7[b]	1/2[b]	12.7[b]	3/8	9.5

[a] Applies to the sum of the spacings involved where an isolated dead part is interposed.

[b] A spacing of not less than 3/8 inch, through air and over surface, is capable of being used at wiring terminals in a wiring compartment or terminal box that is integral with a motor.

31.4 Other than at wiring terminals, the spacing between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead metal part that is exposed to contact by persons or that is capable of being grounded shall not be less than the value specified in Table 31.2.

Exception: Spacings may be as specified in 31.10.

Table 31.2
Spacings at other than field-wiring terminals

Potential involved, volts	Diameter of motor used in product							
	7 inches (178 mm) or less[a]				More than 7 inches (178 mm)[a]			
	Over surface,		Through air,		Over surface,		Through air,	
	inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
0 – 125	3/32[b]	2.4[b]	3/32	2.4	1/4[c]	6.4[c]	1/8[c]	3.2[c]
126 – 250	3/32	2.4	3/32	2.4	1/4[c]	6.4[c]	1/4[c]	6.4[c]
251 – 600	1/2[c]	12.7[c]	3/8[c]	9.5[c]	1/2[c]	12.7[c]	3/8[c]	9.5[c]

[a] This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and similar items, used solely for motor mounting, cooling, assembly, or connection.

[b] For a motor rated 1/3 horsepower (250 watt output) or less, these spacings shall not be less than 1/16 inch (1.6 mm).

[c] Film-coated wire is determined to be an uninsulated live part. However, a spacing of not less than 3/32 inch over surface and through air between film-coated wire, rigidly supported and held in place on a coil, and a dead metal part complies with the intent of this requirement.

31.5 When an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or when a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the required minimum spacing is maintained.

31.6 In a product incorporating two or more motors of different sizes, the spacings in the product shall be evaluated on the basis of the size of the largest motor in the product. See 31.8.

31.7 The spacing requirements in 31.3 – 31.6 do not apply to the inherent spacings of a component of a product, such as a snap switch; such spacings shall be evaluated on the basis of the requirements for the component.

31.8 The spacings in a motor shall comply with the spacing requirements in the Standard for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations, UL 674.

31.9 At terminal screws and studs to which connections are made in the field by means of wire connectors, eyelets, or similar parts, as described in 21.5, spacings shall not be less than those specified

in Table 31.2 when such connectors, eyelets, or similar parts are in such position that minimum spacings – opposite polarity and to dead metal – exist.

31.10 When an isolated dead metal part is interposed between or is in close proximity to:

a) Live parts of opposite polarity,

b) A live part and an exposed dead metal part, or

c) A live part and a dead metal part that is capable of being grounded,

the spacing shall not be less than 3/64 inch (1.2 mm) between the isolated dead metal part and any one of the other parts mentioned in (a) – (c) when the total spacing between the isolated dead metal part and the two other parts is not less than the value specified in Table 31.2.

31.11 An insulating lining or barrier of vulcanized fiber or similar materials employed where spacing would otherwise not comply with the requirements of Table 31.2 shall not be less than 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it is not adversely affected by arcing, except that vulcanized fiber not less than 1/64 inch (0.4 mm) thick complies with the intent of this requirement when used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception: Thinner insulating material complies with the intent of this requirement when it complies with the requirements for internal barriers in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

PROTECTION OF PERSONNEL

32 General

32.1 When the operation and maintenance of a product involves the risk of injury to persons, protection shall be provided to reduce the risk.

32.2 When evaluating a product with respect to the requirement in 32.1, consideration shall be given to reasonably foreseeable misuse of the product.

32.3 The adequacy of a guard, a release, an interlock, and a similar part, and whether such a device is required, shall be determined from an investigation of the complete product, its operating characteristics, and the risk of injury to persons resulting from a cause other than gross negligence. The investigation shall include consideration of the results of breakdown or malfunction of any one component, but not more than one component at a time, unless one breakdown contributes to another malfunction. When the investigation shows the breakdown or malfunction of a particular component is capable of resulting in a risk of injury to persons, that component is to be investigated for its reliability.

32.4 Specific constructions, tests, markings, guards, and similar features are detailed for some common constructions. Specific features and products not covered herein shall be given consideration. See Cautionary Markings, Section 75.

33 Sharp Edges

33.1 An enclosure, a frame, a guard, a handle, or a similar part shall not be of such sharpness to constitute a risk of injury to persons during the intended maintenance and use of the product.

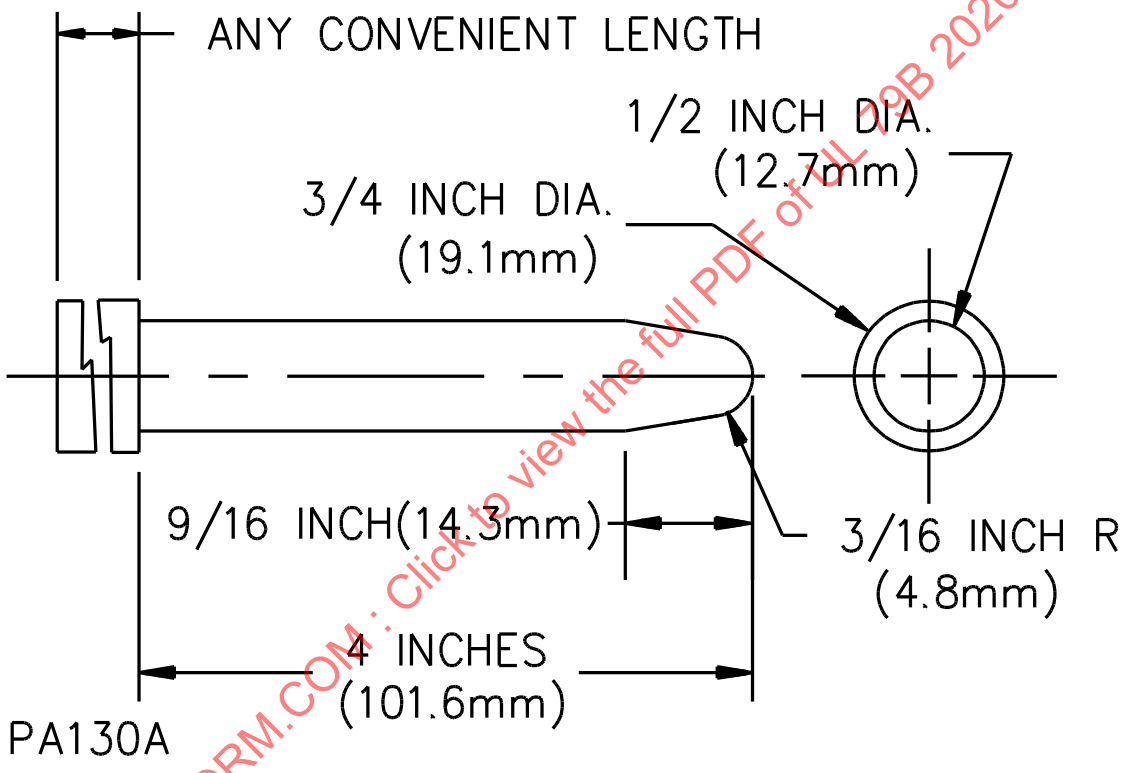
34 Enclosures and Guards

34.1 A moving part that is capable of causing a risk of injury to persons shall be enclosed, guarded, located, or otherwise arranged to reduce the risk of unintentional contact, and such a part shall not be contacted by the probe illustrated in Figure 34.1.

Exception: A part or portion of a part that is exposed to contact in order to perform a specific work function is not required to be enclosed; however, when required, guarding shall be provided. See 34.3.

Figure 34.1

Accessibility probe for moving parts



34.2 A moving part that is capable of resulting in a risk of injury to persons shall be evaluated with respect to:

a) The degree of exposure required to perform the intended function;

b) The sharpness of the moving part;

c) The risk of unintentional contact;

d) The speed of the moving part; and

e) The risk that a part of the body becomes endangered, or that clothing becomes entangled, by the moving part.

These factors are to be evaluated with respect to both the intended operation of the product and its reasonably foreseeable misuse.

34.3 Some guards are required to be of the self-restoring type. Other features of guards that shall be evaluated include:

a) The amount of effort required to remove the guard without the use of tools;

b) The amount of effort required to remove the guard for servicing;

c) Strength and rigidity;

d) Completeness; and

e) The creation of additional risk of injury to persons such as pinch points, and the necessity for additional handling because of the increased need for servicing, such as for cleaning, unjamming, and similar functions.

34.4 An enclosure or guard located over a rotating part shall retain a part that, because of breakage or other reasons, is capable of loosening or separating from a rotating part. The enclosure or guard shall also retain a foreign object that is capable of being struck and propelled by the rotating part.

34.5 When complete guarding of a moving part that obviously causes injury to persons defeats the utility of a product:

a) A control shall be provided and

b) A marking shall be provided in accordance with 75.7.

34.6 During the examination of a product to determine whether it complies with the requirements in 34.1, a part of the enclosure that is capable of being removed without the use of a tool (to attach an accessory, to make an operating adjustment, or for other reasons) shall be opened or removed.

Exception: A part is not required to be opened or removed when it is marked in accordance with 75.6.

35 Materials

35.1 The material of a part, such as an enclosure, a frame, a guard, or similar item, the breakage or deterioration of which is capable of resulting in a risk of injury to persons, shall have such properties as to meet the demand of expected loading conditions.

35.2 The requirement in 35.1 applies to those portions of a part that is adjacent to a moving part that has been determined to involve a risk of injury to persons.

36 Surface Temperatures

36.1 During the Temperature Test described in Section 60, the temperature of a surface that is capable of being contacted by the user shall not be more than the maximum value specified in Table 36.1.

Exception: The temperature of a pump surface and associated fittings and a motor frame that exceeds the applicable limit specified in Table 36.1 complies with the intent of the requirement when the product is marked in accordance with 75.5.

Table 36.1
Maximum surface temperatures

Location	Composition of surface[a]			
	Metallic,		Nonmetallic,	
	°C	(°F)	°C	(°F)
A handle or knob that is grasped for lifting, carrying, or holding	50	122	60	140
A handle or knob that is contacted but does not involve lifting, carrying, or holding, and other surfaces subject to contact in operation and user maintenance	60	140	85	185
A surface subject to casual contact	70	158	95	203

[a] A handle, knob, or similar part made of a material other than metal, that is plated or clad with metal that is less than or equal to 0.005 inch (0.13 mm) thick is determined to be a nonmetallic part.

36.2 All values for temperatures specified in Table 36.1 are based on a 25° C (77° F) ambient temperature. Tests that are conducted at any ambient temperature within the range of 20 – 30° C (68 – 86°F) comply with the intent of this requirement.

37 Locking Mechanism

37.1 When a pump assembly has provision for storing a hose-nozzle valve, it shall be provided with effective means for locking both the motor switch and each hose-nozzle valve. The locking mechanism shall be constructed so that a simple locking operation for each pump control prevents the motor from starting and prevents the discharging of even small quantities of gasoline through the pump outlet. When the locking means is based upon the use of a padlock, the padlock [which has a minimum 1/4 inch (6.4 mm) diameter shackle] is not required to be supplied with the product.

38 Control Application

38.1 When a pump assembly has provision for storing a hose-nozzle valve, the motor shall not be energized when the nozzle valve is in the stored position and shall not be able to start simultaneously with the lifting of the hose or its nozzle from its position on the device. A separate intentional manual operation shall be required for closing the starting switch. The motor circuit shall be opened at the time or before the hose is returned to its position on the device following operation.

38.2 As a means of complying with 38.1, the motor circuit may be opened by the weight of the hose and nozzle upon replacement in their intended position. Also, interference devices may be provided to prevent replacement of the nozzle until the opening of the motor circuit has been accomplished.

38.3 The discharge of liquid shall occur only when:

a) The hose-nozzle valve is manually held in the open position or

b) The hose-nozzle valve is of the automatic-closing type with latch-open device, when the valve mechanism is latched to maintain the valve in the open position.

The discharge of liquid shall be stopped immediately upon the release of the hand control by the operator or the functioning of an automatic-closing mechanism.

39 Secondary Circuits

39.1 General

39.1.1 A secondary circuit shall either comply with the requirements in 39.1.2 – 39.2.2, or it shall comply with the requirements for a primary circuit. Any circuit that is relied upon to reduce the risk of fire, electric shock, or injury to persons shall comply with the requirements for a primary circuit.

39.1.2 A low-voltage circuit as defined in 3.6 and supplied by a single source consisting of a power transformer or a power supply that includes an isolating transformer is not required to be investigated.

39.1.3 With reference to 39.1.2, a low-voltage circuit that complies with the applicable requirements for secondary circuits in the Standard for Industrial Control Equipment, UL 508, is determined to be in compliance with the requirement.

39.1.4 A Class 2 transformer shall comply with the applicable requirements in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception: The temperature rise measured by the resistance method for coils of a Class 2 transformer employing Class 105 insulation systems shall not exceed 85°C (153°F) as specified in Table 60.1.

39.1.5 Power distribution components, such as bus bars, wiring, connectors, and similar parts, up to and including printed-wiring receptacles and connectors, shall comply with the applicable requirements in Internal Wiring, Section 24. Printed-wiring boards and insulated wires used in such circuits shall be rated for the application. See 23.4.

39.2 Protection of wiring

39.2.1 With reference to 39.1.5, wiring located in a secondary circuit shall be routed away from the wiring of other circuits or shall be provided with insulation that is rated for use at the highest voltage of the circuits involved.

39.2.2 In addition to complying with 39.2.1, wiring that is part of a secondary circuit shall be provided with strain relief when stresses on the wiring are capable of resulting in the wiring contacting uninsulated live parts of other circuits.

PERFORMANCE

40 General

40.1 A representative sample of each size and specific design of pump is to be subjected to the tests described in these requirements. Additional samples of parts constructed of nonmetallic materials are required for physical and chemical tests.

40.2 All tests shall be performed using the test fluids specified for that test. No substitution of test fluids is allowed. When the test indicates that FB25a or B100a are to be used, the test fluid shall be prepared as described in Supplement SA.

40.3 Water is to be used for developing the required pressure in the hydrostatic pressure test. All hydrostatic pressures are to be maintained for at least 10 minutes.

40.4 Clean air or nitrogen is to be used for developing the required pressure in a leakage test of vapor or pneumatic handling parts of a pump. All joints and body surfaces are to be brushed with soap and water or other leak detection solution and determined to be free of any bubbles.

40.5 The investigation of a pump is to be limited to the intended end-use conditions of speed and maximum discharge pressure for which it is recommended.

40.6 All tests on electrically-operated pump assemblies are to be conducted with the product connected to a supply circuit of rated frequency. The voltage and frequency of the supply circuit is to be:

a) 120 volts, 60 hertz for a product rated from 110 volts up to and including 120 volts, 60 hertz;

b) 240 volts, 60 hertz for a product rated from 220 volts up to and including 240 volts, 60 hertz; or

c) The maximum rated voltage for a product rated 60 hertz and other than as specified in (a) or (b).

40.7 A product rated 50/60 hertz is to be tested at the maximum rated voltage for each frequency for the Input Test. Except for the Dielectric Voltage-Withstand Test, Section 61, all other tests shall use the voltage-frequency rating at which the highest input wattage was measured during the Input Test.

40.8 A product rated DC/50 hertz is to be tested at the maximum rated voltage and at the rated frequency.

40.9 Material compatibility of a pump assembly shall be tested using the following test sequence. All other tests can be performed in any order on any samples.

a) Long Term Exposure Test, Section 41;

b) High Pressure Leakage Test, Section 42;

c) Endurance Test – Pumps, Section 43;

d) High Pressure Leakage Test, Section 42;

e) Hydrostatic Strength Test, Section 44.

40.10 To reduce the effects of seal dry out due to removal of the test fluid after specific tests in the test sequence d in 40.9, each subsequent test shall be started within 4 hours of removal of the test fluid from the previous test. If necessary to coordinate testing, the sample may be left filled with the most recent test fluid at room temperature until the next test is initiated. If the previous test used water as the test fluid, the sample shall be filled with kerosene.

41 Long Term Exposure Test

41.1 General

41.1.1 The test d in 41.2 – 41.4 is to be performed on one or two samples of the device. If the product is rated for use with diesel fuel (B0 - B5), a diesel/biodiesel blend above 5 percent but not greater than 20 percent biodiesel (B6 – B20), kerosene or fuel oil, then the test shall be performed using the FB25a test fluid. If the product is rated for use with biodiesel (B99.9/B100), then the test shall be performed using the B100a test fluid. See Supplement SA.

41.2 Samples

41.2.1 A sample of a complete pump is to be tested. All inlet and outlet openings of the samples shall be sealed in accordance with 41.2.3.

41.2.2 If platings or coatings are used internal to the device, additional samples may be used. See 41.4.2.

41.2.3 Closures shall be provided to seal off inlet and outlet openings on the samples. These closures shall be fabricated of suitable materials. The main inlet and outlet closures shall be provided with a 1/4 inch NPT opening for connection to the test apparatus. All closures shall be installed by the manufacturer and provided with a torque rating. There will be no other adjustment to connections for the duration of the test.

41.2.4 Any o-rings, gaskets, or other sealing materials, shall be provided and installed by the manufacturer. The dynamic sealing devices shall be the same as those that will be used in the final product installation. Static seals shall be representative of the seals being used in the final product installation. If the sealing device or material is not considered part of the component under test, but will be provided in an end product at the time of installation, a representative seal shall be provided for the test.

41.2.5 For submersible transfer pumps, the electrical conduit shall be left open to assist in verification that the test fluid does not enter the electrical portion of the device during the tests.

41.3 Method

41.3.1 The sample is to be exposed to the applicable test fluid in accordance with 41.1.1. The test fluids shall be prepared using the instructions in Supplement SA.

41.3.2 A quick connect device is connected to the 1/4 inch NPT connection at the inlet, and it is used to fill the samples with the applicable test fluids. A source of pressure may be used to assist in filling or draining the samples, however, the pressure shall not exceed the rated pressure of the device under test. Once the samples are filled to exclude all air, they are closed off and sealed. The samples are then placed in the test chamber.

41.3.3 The chamber temperature is increased to 60 ±2°C (140 ±4°F). When the chamber reaches this temperature, the exposure period begins. The samples are exposed to the applicable test fluid at 60 ±2°C for approximately 168 hours. At the end of this duration, the exposure period is halted and the chamber is allowed to cool. The samples are subjected to a 50 psi (347 kPa) pressure for one minute. The fluid is then drained from the samples and discarded. The samples are then immediately refilled with new test fluid and the chamber temperature is allowed to increase to 60 ±2°C again. The total duration of the test shall equal 2520 hours of exposure at 60 ±2°C.

41.3.4 At the end of the total exposure duration, the test fluid is left in the samples and the samples are removed from the chamber. The samples are then subjected to the appropriate test sequence as d in 40.9 and in accordance with 40.10. Prior to the initiation of the test sequence, the test fluid is to be drained and discarded.

41.3.5 If the device contains any parts or surfaces that are plated or coated, if the device uses casting impregnation materials to eliminate porosity leakage, or if the device contains internal nonmetallic parts, the plating, coating, impregnation, or internal parts are tested both during and after this exposure. See 41.4.2 and 41.4.4.

41.4 Results

41.4.1 There shall be no leakage during this test. If leakage is observed at any point during the test, the test is to be stopped.

41.4.2 For platings or coatings, there shall be no softening of the plating or coating material. Compliance is checked by observance of the drained test fluid. There shall be no evidence of visible flaking or material. In addition, there shall be no substantial discoloration of the test fluid when observing the drained fluid. Discoloration is an indication of chemical attack on the plating or coating internal to the device. In order to determine that the base metal is not exposed, visual inspections shall be made. If the visual examination requires examination of internal surfaces, the samples shall be cut open to determine compliance. If this is necessary, additional samples can be used to determine compliance with this requirement, such that the remaining test sequence will not be disturbed by cutting open the samples.

41.4.3 For casting impregnation materials, the sample shall not show evidence of porosity leakage during or after the fluid exposure duration.

41.4.4 For internal nonmetallic parts, there shall be no visible evidence of this material in the drained test fluid.

41.4.5 For submersible transfer pumps, a dielectric strength test shall also be performed in accordance with Dielectric Voltage-Withstand Test, Section 61.

42 High Pressure Leakage Test

42.1 The liquid confining parts of a pump shall withstand an internal hydrostatic pressure of 1.5 times the maximum discharge or inlet pressure, but not less than 75 psi (520 kPa) without leakage to the outside, to air confining parts of the pump, or to wiring compartments, and without evidence of casting porosity. This test is to be conducted as described in 42.4.

42.2 The air-confining parts of a pneumatically-powered pump shall not leak externally at a rate in excess of 1.5 feet^3 (42,500 cm^3) per hour when tested with air or nitrogen at the maximum rated pressure.

42.3 In preparing for this test, the means provided for the prevention of or the relief of pressures as described in Pressure Relief, Section 14, are to be nullified, and any extractable section of a submersible-type pump is to be disconnected, withdrawn, and reinserted 10 times. Following the tenth withdrawal, there shall be no damage to gaskets, seal rings, or other sealing devices or surfaces, as determined by visual examination.

42.4 The test pump is to be connected to a source of hydrostatic pressure. A positive shutoff valve and a pressure indicating device are to be installed in the supply piping. The pressure indicating device is to be installed in the piping between the shutoff valve and the test pump. The pressure indicating device shall comply with one of the following.

a) An analog gauge having a pressure range such that the test pressure is between 30 and 70 percent of the maximum scale reading of the gauge;

b) A digital pressure transducer, or other digital gauge, that is calibrated over a range of pressure that includes the test pressure; or

c) Other device that is equivalent to the devices in (a) or (b).

While the pump is under the applied test pressure, the drive shaft or an operating shaft stuffing box or seal, and all joints and body casting surfaces are to be examined for evidence of leakage.

42.5 Conduit connections and wiring compartments subject to immersion in or contact with the fuels anticipated by these requirements, and motors intended to be isolated from such liquids, are to be sealed to prevent leakage at differential pressures up to the maximum discharge pressure or the pressures developed at the maximum immersion depth when tested in accordance with 42.8. See Electrical Equipment, Section 20.

42.6 For pump assemblies subject to pressure, the conditions specified in 42.5 are to be introduced by applying to the external sections of the conduit, compartment, or motor, for at least 1 minute, an aerostatics pressure varying from zero up to the value specified.

42.7 For assemblies subject to immersion, the conditions specified in 42.5 comply with the intent of this requirement when no water has entered the conduit, compartment, or motor at the conclusion of the test specified in 42.8.

42.8 The complete product is to be mounted in a tank with the conduit connected using a pipe thread sealing compound. The conduit is to be tightened with the torque specified in Table 46.1. The tank is to be filled with water so that the highest point on the enclosure is at the maximum rated immersion depth below the surface of the water or when installed as intended. The enclosure is not required to be submersed to this depth when an equivalent pressure differential between the interior and the exterior of the enclosure is maintained for the required period of time. This differential is capable of being achieved either by reducing the air pressure inside the product or by pressurizing the water surrounding the product. After 30 minutes, the product is to be removed from the tank, the excess water is to be removed from the exterior surface of the product, and the product is to be opened.

42.9 A pump that shows evidence of leakage under conditions of a ruptured diaphragm or bellows, from an untreated vent opening, or around any pins, stems, or linkage passing through the housing in excess of the following rate does not comply with the intent of the requirements in 8.2 when the pump is tested to its maximum rated discharge pressure. The leakage rate is one thousand cubic centimeters per hour of water.

42.10 Valve mechanisms of an air separator that vents to atmosphere shall withstand a hydrostatic pressure of 75 psig (520 kPa) for one minute without displaying any evidence of leakage within the pump in which the device is located. Prior to the test, the pump in which the valve mechanism is installed is to be prepared in the manner described in 42.3 and 42.4.

43 Endurance Test – Pumps

43.1 A sample of a pump assembly previously subjected to the Long Term Exposure Test, Section 41, shall not leak during or after the test described in 43.2.

43.2 The test is performed using kerosene as the test fluid. The pump is to be operated continuously for 300 hours at the maximum discharge pressure of the pump. The pump shall be observed for indications of leakage at all joints, or indications of porosity leakage.

44 Hydrostatic Strength Test

44.1 Liquid-handling parts of a pump shall withstand, without rupture or permanent distortion, a hydrostatic pressure five times the maximum discharge pressure for ten minutes.

44.2 An air separator housing that is vented to atmosphere shall withstand rupture or permanent distortion a hydrostatic pressure of 100 psig (690 kPa). An air separator housing that is not vented to atmosphere shall withstand without rupture or distortion a hydrostatic pressure of 250 psig (1720 kPa).

44.3 Pneumatic-handling parts of a pump shall withstand, without rupture, a hydrostatic pressure of five times the maximum air inlet pressure applied for ten minutes.

44.4 The pump sample is to be connected to a source of hydrostatic pressure. A positive shutoff valve and a pressure indicating device, are to be installed in the hydrostatic pressure supply piping. The pressure gauge is to be installed in the piping between the shutoff valve and the pump under test. The pressure indicating device shall comply with one of the following:

a) An analog gauge having a pressure range such that the test pressure is between 30 and 70 percent of the maximum scale reading of the gauge;

b) A digital pressure transducer, or other digital gauge, that is calibrated over a range of pressure that includes the test pressure; or

c) Other device that is equivalent to the devices in (a) or (b).

44.5 External leakage observed during this test does not constitute a failure when, following the hydrostatic test, the pump complies with the requirements specified in the High Pressure Leakage Test, Section 42.

44.6 A conduit seal in a factory sealed device shall withstand for 10 minutes, without rupture or permanent distortion, a hydrostatic test pressure of 600 psig (4.148 Mpa). When unintended leakage results in the inability of the test apparatus to maintain the required test pressure during the test of a seal for a 2-inch (60.3 mm outside diameter) or larger trade size conduit with wires sealed in place, a device with a seal and without wires may be used. The hydrostatic pressure is to be gradually increased until the required internal pressure is reached. Gaskets or other means shall be used when required to prevent leakage of water during application of pressure.

45 Retention Test for Screws and Bolts

45.1 Screws or bolts used to attach parts which are detached for maintenance or servicing of the pump shall perform their intended function upon the application of the torques indicated in Table 45.1 after their removal and replacement.

Table 45.1
Maximum torque requirements for screws or bolts

American standard screw size,		Torque,		I.S.O. screw size,	Torque,	
No.	(mm)	lb-in	(N·m)	mm	N·m	(lb-in)
–	–	–	–	4	1.6	14
8	4.2	18	2.0	4.5	2.6	23
10	4.8	30	3.4	5	4.2	37
inch	(mm)					
1/4	6.4	100	11.3	6	8.7	77
–	–	–	–	7	15.0	133
5/16	7.9	200	22.6	8	23.5	208
–	–	–	–	9	33.6	297
3/8	9.5	350	39.6	10	45.2	400
7/16	11.1	575	65.0	12	81.0	715
1/2	12.7	850	96.0	14	128.0	1130
9/16	14.3	1200	136.0	–	–	–
5/8	15.9	1600	181.0	16	185.0	1640

46 Deformation Test

46.1 Joints in a pump shall not leak, nor shall there be evidence of damage resulting from the turning effort exerted on pipe-threaded sections that have been tested as described in 46.2 and 46.3.

46.2 The sample pump used in this test is to be rigidly anchored or otherwise supported. A section of Schedule 80 pipe whose threads have been lubricated with SAE No. 10 machine oil and of sufficient length for wrench engagement is to be connected to a female pipe-threaded section of the pump. Each pipe then is to be tightened to the torque specified in Table 46.1.

46.3 After the torque force has been applied to each connected pipe or fitting, the pump is to be subjected to the High Pressure Leakage Test, Section 42.

Table 46.1
Torque requirements for pipe connections

Pipe size ANSI B36.10M, nominal inches	Outside diameter,		Torque,	
	inches	(mm)	pound-inches	(N·m)
1/8	0.405	10.29	150	17
1/4	0.540	13.72	250	28
3/8	0.675	17.15	450	51
1/2	0.840	21.34	800	90
3/4	1.050	26.67	1000	113
1	1.315	33.40	1200	137
1-1/4	1.660	42.16	1450	164
1-1/2	1.900	48.26	1550	175
2	2.375	60.33	1650	186
2-1/2	2.875	73.03	1750	198
3	3.500	88.90	1800	203
4	4.500	114.30	1900	215

47 Leakage of Wire Seal Test

47.1 A wire seal shall not enable the passage of more than 0.007 cubic foot (200 cc) of air per hour at a pressure of 6 inches (152 mm) of water.

47.2 The number and sizes of wires that are to be sealed in each wire seal are to be as specified in Table 47.1, or shall be the maximum number and size of wires and wire insulation used in the product. The ends of the wires may be sealed during the test.

Table 47.1
Internal wiring for wire seals

Conduit trade size of fittings,			Size of wires,	
inches	(mm OD)	Number of wires	(AWG)	(mm^2)
1/2	21.3	7	18	0.82
3/4	26.7	10	16	1.3
1	33.4	10	14	2.1
1-1/4	42.4	13	10	5.3
1-1/2	48.3	10	8	8.4

48 Endurance Test for Air Separators

48.1 The valve mechanism of an air separator constructed as described in 11.2 shall be subjected to 100,000 cycles of operation. At the conclusion of the test, the valve mechanism shall continue to function as intended by the manufacturer.

49 Blocked Outlet Test

49.1 With an outlet control valve fully closed to direct all of the pump discharge through a bypass or relief valve or to stop the pumping action by the means provided, the discharge pressure of a power-operated pump shall not exceed the maximum discharge pressure.

49.2 This test is to be conducted with normal energy supply (rated voltage, or maximum air or liquid inlet pressure) to the pump using kerosene as the test liquid.

50 Pressure Relief Test

50.1 A pump assembly, when de-energized, shall prevent an increase of pressure in excess of the maximum discharge pressure as the result of thermal expansion of the liquid remaining in a closed discharge system.

50.2 Compliance with the requirements in 50.1 shall be demonstrated by test unless the pump unit is provided with a bypass valve, a fixed bypass opening, or a relief valve as described in 14.2 (a) and (b). The test is to be conducted with the pump unit de-energized and the inlet connection open to observation. A short, valved pipe section is to be connected to the pump discharge opening and connected to a liquid pressure supply. The liquid is to be admitted to the discharge section of the pump until the section has been pressurized to at least 120 percent of the maximum discharge pressure.

50.3 Immediate evidence of liquid being discharged from the inlet connection, the immediate reduction in pressure in the discharge pipe connection to the maximum discharge pressure or lower, or both, are determined to be criteria for compliance with the requirements of this test.

51 Float Buoyancy Test

51.1 During this test, the float is to be removed from the actuating mechanism and the force required to actuate the mechanism is to be measured by a force gauge.

51.2 Each float shall be attached to a weight equal to 1.5 times the force measured in accordance with 51.1. The float and weight for all three samples are to be placed in the test fluid. The top of the float is not to be beneath the surface of the test fluid.

51.3 The weight noted in 51.2 is to be equal to 1.23 times the weight when the test fluid is kerosene or 1.47 times the weight when the test fluid is water.

52 Dimensional Stability of Floats Test

52.1 A set of three samples of the float shall be used for this test for each test fluid exposure in accordance with Supplement SA. Prior to the immersion conditioning described in 52.2, the dimensions (length and diameter or thickness) of each float are to be determined with appropriate measuring instruments. Immediately following the immersion conditioning, and after drying in air for 70 ±1.2 hours at 23 ±2° C (73 ±3.6° F), the dimensions of each float shall be measured. The percentage change in dimensions is to be calculated as specified in the following equation for each of the three samples and then averaged.

$$\frac{[(Mb - Ma) \times 100]}{Mb}$$

in which:

Mb is the dimension of the sample before the immersion conditioning and

Ma is the dimension of the sample after the immersion conditioning.

52.2 For products rated for diesel or diesel/biodiesel blends with a nominal biodiesel concentration of up to 20 percent (B0 – B20), the test shall be performed on one set of samples using the FB25a test fluid. If the product is rated for biodiesel then the test shall be performed on two sets of samples using both the FB25a and B100a test fluids. See Supplement SA. Each set of samples shall be immersed (completely submerged) in vessels containing the applicable test fluids for 168 hours at 23 ±2°C (73.4 ±3.6°F)

52.3 At the conclusion of the test described in 52.2, the percentage change in dimension shall not change by more than 2 percent.

53 Weight Change of Floats Test

53.1 A set of three samples of the float shall be used for this test for each test fluid exposure in accordance with Supplement SA. Prior to the immersion conditioning described in 53.2, the weight of each sample is to be determined with an analytical balance. Immediately following the immersion conditioning, and after being dried in air for 70 ±1.2 hours at 23 ±2°C (73.4 ±3.6°F), the weight of each sample is to be measured. The percentage change in weight is to be calculated as specified in the following equation for each of the three samples in each set and then averaged.

$$\frac{[(Mb - Ma) \times 100]}{Mb}$$

in which:

Mb is the weight of the sample before the immersion conditioning and

Ma is the weight of the sample after the immersion conditioning.

53.2 For products rated for diesel or diesel/biodiesel blends with a nominal biodiesel concentration of up to 20 percent (B0 – B20), the test shall be performed on one set of samples using the FB25a test fluid. If the product is rated for biodiesel then the test shall be performed on two sets of samples using both the FB25a and B100a test fluids. See Supplement SA. Each set of samples shall be immersed (completely submerged) in vessels containing the applicable test fluids for 168 hours at 23 ±2°C (73.4 ±3.6°F).

53.3 At the conclusion of the test described in 53.2, the percentage change in weight shall not increase by more than 25 percent or decrease by more than 10 percent.

54 Float Crushing Test

54.1 Two samples of a hollow float are to be subjected to this test. Each float is to be first checked for freedom from leakage by being suddenly immersed in water heated to a temperature immediately below the boiling point and observed for 3 minutes for the appearance of bubbles. When no leakage is observed, each float then is to be placed in a container of a size and strength suitable for its intended use. The container is to be connected to a source of hydrostatic pressure, and a calibrated pressure gauge is to be installed in the pressure supply piping. The container is to be completely filled with liquid to expel all air.

The pressure then is to be gradually increased over a period of at least 1 minute to 35 psig (240 kPa) and maintained for 1 minute.

54.2 Subsequent to the test, the floats are to be removed from the container and examined for evidence of distortion and leakage. No distortion or leakage is to be observable before and after the float is cut in half.

55 Moist Ammonia-Air Stress Cracking Test

55.1 After being subjected to the conditions described in 55.2 – 55.4, a pressure confining brass part containing more than 15 percent zinc shall:

a) Show no evidence of cracking, delamination, or degradation, or

b) Perform as intended when tested as described in 55.4.

55.2 One test sample of each size is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Samples with female threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened as specified in Table 46.1. Samples with female threads other than tapered pipe threads shall be torqued as specified by the manufacturer. Polytetrafluoethylene (PTFE) tape or pipe compound are not to be used on any threads. Samples with male threads are evaluated as received.

55.3 The samples are then to be tested in accordance with Apparatus, Section 6, Reagents and Materials, Section 7, Test Media, Section 8, Test Sample Preparation (9.3 – 9.4), Test Procedure (10.1 – 10.4) of the Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys, ASTM B858-06, except the pH level of the test solution shall be High 10.5 ±0.1 and the exposure temperature shall be 25 ±1°C.

55.4 After the exposure period, the samples are to be examined for cracks or other signs of stress corrosion using a microscope having a magnification of 25X. Pressure-confining parts exhibiting degradation as indicated in 55.1 as a result of the test exposure described in 55.2 and 55.3 shall withstand, without rupture, a hydrostatic test pressure of five times the rated pressure of the valve, for 1 minute.

56 Tests on Sealing Compounds

56.1 A sealing compound used as a conduit seal as covered in 20.9 shall comply with the requirements in 56.2 – 56.7, or 56.8, to determine its resistance to the fuels anticipated by these requirements.

56.2 The resistance to crushing of the sealing compound is to be determined on as-received specimens and specimens exposed to test vapors of test fluids. The crushing force after exposure is to be at least 85 percent of the value determined using as-received samples. In addition, changes in dimensions and weight after exposure are to be determined. Shrinkage or loss of weight of more than 1 percent or an increase in weight or swelling that changes the intended properties of the sealing compound does not comply with the intent of this requirement. See 56.8.

56.3 Cylindrical specimens 1/2 inch (12.7 mm) in diameter and 3/4 inch (19.1 mm) long are to be used for the tests. Sample sets consist of six samples for each test fluid and three for as-received tests. See 56.4.

56.4 For products rated for diesel or diesel/biodiesel blends with a nominal biodiesel concentration of up to 20 percent (B0 – B20), the test shall be performed on one set of samples using the FB25a test fluid. For products rated for biodiesel (B99.9/B100) the test shall be performed on two sets of samples, with one set

exposed to the FB25a test fluid and the second set exposed to the B100a test fluid. See Supplement SA. The specimens are to be exposed for 168 hours (7 days) to saturated vapors of the applicable test fluids as separate tests.

56.5 During and after the exposure, the specimens are to be observed for discoloration, swelling, crazing, leaching, or dissolving.

56.6 After the exposure, three specimens from each fluid exposure are to be weighed and measured immediately after removal from the fluid vapor.

56.7 The other three exposed specimens and the as-received specimens are to be placed between two parallel plates and crushed with a compression-testing machine having a crosshead speed 0.1 inch (2.54 mm) per minute. The load is to be applied perpendicular to the axis of the cylindrical specimens and the compressive force required to crack and break the specimens is to be recorded.

56.8 As an alternative to the requirements of 56.2 – 56.7, the Hydrostatic Strength Test described in 44.6 is to be used to determine resistance of the sealing compound to the fuels anticipated by these requirements. The Hydrostatic Strength Test is to be conducted on two complete samples of the pump that incorporate the sealing compound after the samples are exposed to saturated vapors of the chemicals specified in 56.4 for 168 hours at 25°C (77°F) and then dried in air for 24 hours after each exposure. This constitutes one cycle. One sample is to be subjected to eight cycles and the other sample to sixteen cycles of exposure and drying for a total of 1536 hours (64 days), and for a total of 3072 hours (128 days). There shall be no rupture, cracking, breakage, or other damage to the sealing compound. Two samples are to be used for each fluid exposure.

57 Metallic Coating Thickness Test

57.1 The solution to be used for this test is to be made from distilled water and is to contain 200 grams per liter of chemically pure chromic acid (CrO_3); and 50 grams per liter of chemically pure concentrated sulfuric acid (H_2SO_4). The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

57.2 The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube of approximately 0.025 inch (0.64 mm) inside bore and 5.5 inches (140 mm) long. The lower end of the capillary tube is to be tapered to form a tip, the drops from which are to be approximately 0.025 milliliters. To maintain an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that the rate of dropping is 100 ±5 drops per minute when the stopcock is open. When desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

57.3 The sample and the test solution are to be kept in the test room long enough to acquire the temperature of the room maintained at an ambient temperature of 20 – 30°C (70 – 90°F).

57.4 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint and other nonmetallic coatings are to be removed completely by means of solvents. Samples then are to be thoroughly rinsed in water and dried. The cleaned surface is not to contact the hands or any foreign material.

57.5 The sample to be tested is to be supported from 0.7 – 1 inch (18 – 25 mm) below the orifice, so that the drops of solution strike the point to be tested and run off. The surface to be tested is to be inclined approximately 45 degrees from horizontal.

57.6 The stopcock is to be opened and the time, in seconds, required for the dropping solution to dissolve the protective metallic coating and expose the base metal is to be measured. Exposure of the

base metal is to be considered as the first appearance of the base metal recognizable by the change in color at that point.

57.7 Each sample of a test lot is to be tested at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface, and at an equal number of points on the outside surface, at places on both surfaces where the metallic coating may be expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

57.8 The thickness of the coating being tested is to be calculated by selecting from Table 57.1 the thickness factor appropriate for the temperature at which the test was conducted, and multiplying that thickness factor by the time, in seconds, required to expose base metal as noted in 57.6.

Table 57.1
Thickness of coatings

Temperature,		Thickness factors, 0.00001 inches (0.0003 mm) per second	
°F	(°C)	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

58 Starting Current Test

58.1 A pump shall start and operate as intended by the manufacturer on a circuit protected by a non-time-delay fuse having a current rating corresponding to that of the branch circuit to which the pump is intended to be connected. The performance does not comply with the intent of this requirement when the fuse opens or an overload protector provided as part of the pump trips.

Exception: A pump that meets all of the following conditions is not required to comply with these requirements:

a) The construction of the pump or the nature of its use is such that the pump is used continuously on the same branch circuit after installation;

b) The pump starts and operates as intended on a circuit protected by a time-delay fuse; and

c) The product is marked in accordance with 74.10.

58.2 To determine compliance with the requirement in 58.1, the pump is to be started three times from a standstill without the opening of the fuse. The pump is to be at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation, and the motor is to come to rest between successive starts. The outlet of the pump is to be blocked.

59 Input Test

59.1 The current or wattage input to a product shall not be more than 110 percent of the rated value when the product is operated under the condition of maximum normal load as described in 60.2 and when connected to a supply as specified in 40.6.

60 Temperature Test

60.1 General

60.1.1 A pump, when tested under the conditions of maximum normal load, as described in 60.2.1, shall not exceed the temperature rises specified in Table 60.1.

Exception: A maximum temperature measured on a pump that exceeds the temperature rises specified in Table 60.1 complies with the intent of this requirement when the elevated temperature is determined not to result in a risk of fire or damage to materials used in the product in which the pump is installed.

60.1.2 A thermal- or overload-protective device shall not open the circuit during the temperature test.

60.1.3 All values of temperature rise in Table 60.1 are based on an assumed ambient temperature of 25° C (77°F). Tests that are conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F) meet the intent of this requirement. The test fluid being pumped is to be maintained at a temperature in the range of 15 – 25°C (59 – 77°F).

Table 60.1
Temperature rises

Materials and components	°C	(°F)
A. MOTORS		
1. Class A insulation systems on a coil windings of an AC motor having a frame diameter of 7 inches (178 mm) or less, not including a universal motor and on a vibrator coil[a,b]		
a) In an open motor and on vibrator coil:		
Thermocouple or resistance method	75	135
b) In a totally enclosed motor:		
Thermocouple or resistance method	80	144
2. Class A insulation systems on coil windings of an AC motor having a frame diameter of more than 7 inches (178 mm), of a DC motor and of a universal motor[a,b]		

Table 60.1 Continued on Next Page

Table 60.1 Continued

Materials and components	°C	(°F)
a) In an open motor:		
Thermocouple method	65	117
Resistance method	75	135
b) In a totally enclosed motor:		
Thermocouple method	70	126
Resistance method	80	144
3. Class B insulation systems on coil windings of an AC motor having a frame diameter of 7 inches (178 mm) or less, not including a universal motor[a,b]		
a) In an open motor:		
Thermocouple or resistance method	95	171
b) In a totally enclosed motor:	100	180
Thermocouple or resistance method		
4. Class B insulation systems on coil windings of an AC motor having a frame diameter of more than 7 inches (178 mm), of a DC motor, and of a universal motor[a,b]		
a) In an open motor:		
Thermocouple method	85	153
Resistance method	95	171
b) In a totally enclosed motor:		
Thermocouple method	90	162
Resistance method	100	180
5. Class F insulation systems on coil windings of an AC motor having a frame diameter of 7 inches (178 mm) or less, not including a universal motor[b]		
a) In open motor:	120	216
Thermocouple or Resistance Method	125	225
b) In totally enclosed motor:		
Thermocouple or Resistance Method	125	225
B. COMPONENTS		
1. Capacitors:		
a) Electrolytic	40[c]	72[c]
b) Other types	65[d]	117[d]
2. Fuses	65[e]	117[e]
3. Relay, solenoid, and coils (except motor coil windings and transformers) with		
a) Class 105 insulation systems:		
Thermocouple method	65	117
Resistance method	85	153
b) Class 130 insulation systems:		
Thermocouple method	85	153
Resistance method	95	171
c) Class 155 insulation systems:		
Thermocouple method	95	171
Resistance method	115	207
d) Class 180 insulation systems:		

Table 60.1 Continued on Next Page

Table 60.1 Continued

Materials and components	°C	(°F)
Thermocouple method	115	207
Resistance method	135	243
4. Sealing Compound	40	104 less than melting point
5. Synthetic rubber materials	35[f]	63[f]
6. Transformers		
a) Class 155 insulation systems:		
Thermocouple method	110	198
Resistance method	115	207
b) Class 180 insulation systems:		
Thermocouple method	125	225
Resistance method		
C. CONDUCTORS	135	243
Rubber- or thermoplastic insulated wires and cords	35	63[f,g]
D. ELECTRICAL INSULATION – GENERAL		
1. Fiber employed as electrical insulation	65	117
2. Phenolic composition employed as electrical insulation or as a part, the deterioration of which results in a risk of fire or electric shock[e]		
Laminated	100	180
Molded	125	225
3. Varnished-cloth insulation	60	108
E. SURFACES		
1. A surface upon which a product may be or mounted in service, and a surface that may be adjacent to the product when it is so placed or mounted	65	117
2. Any point within a terminal box or wiring compartment of a permanently connected product in which power-supply conductors are to be connected, including such conductors themselves, unless the product is marked in accordance with 74.13.	35	63
3. Wood or other combustible material, including the inside surface of the test enclosure and the surface supporting the product	65	117

[a] See 60.1.4 and 60.2.

[b] For a motor rated 1/3 horsepower (250 watts output) or less, these spacings may be less than 1/16 inch (1.6 mm).

[c] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum temperature rise on insulating material integral with the capacitor enclosure is not to be more than 65°C (117°F).

[d] A capacitor that operates at a temperature rise of more that 65°C (117°F) may be judged on the basis of its marked maximum temperature limit.

[e] A fuse that has been investigated and successfully evaluated for use at a higher temperature may be used at that temperature. These limitations do not apply to compounds and compounds such as fuses that have been successfully investigated for use at a higher temperature.

[f] A synthetic rubber material that operates at a temperature rise of more than 35°C (63°F) complies with the intent of this requirement when investigated for the higher service temperature in accordance with the Standard for Gaskets and Seals,UL 157.

[g] A rubber-insulated conductor within a motor, a rubber-insulated motor lead, and a rubber-insulated conductor of a flexible cord when entering a motor may be subjected to a higher temperature when the conductor is provided with sleeving or a braid that has been investigated and successfully evaluated for use at the higher temperature. This does not apply to thermoplastic-insulated wires or cords.

60.1.4 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by a means of a thermocouple that is more than the maximum temperature specified in Table 60.1 meets the intent of this requirement when the temperature, as measured by the resistance method, is not more than that specified in Table 60.2.

Table 60.2
Maximum coil temperatures

Subitem of item in Table 60.1		Additional temperature rise, °C	(°F)
1.	(a) of item A1	5	9
2.	(a) of item A3	10	18
3.	(a) of item A2	15	27
4.	(a) of item A4	20	36

60.1.5 For the temperature test, the voltage shall be as indicated in 40.6.

60.1.6 A product having a single frequency rating is to be tested at that frequency. A product rated AC/DC or DC or 60 hertz is to be tested on direct current or 60-hertz AC, whichever results in higher temperatures. A product rated 25 – 60 hertz or 50 – 60 hertz is to be tested at the voltage and frequency rating at which the highest input wattage was measured during the Input Test, Section 59.

60.1.7 For a product that is obviously not intended for continuous operation, the probable intermittent or short-time operation of the product is to be taken into consideration when conducting the temperature test.

60.1.8 With reference to those tests that are to be continued until constant temperatures are attained, thermal equilibrium exists when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, however, not less than 5-minute intervals, indicate no change.

60.1.9 Coil winding temperatures are to be measured by thermocouples or by using the change-of-resistance method, whichever is appropriate. For a thermocouple-measured temperature of a coil of an alternating-current motor having a diameter of 7 inches (178 mm) or less, and a universal motor – see items 1 and 3 in Table 60.1 – the thermocouple is to be mounted on the integrally applied insulation on the conductor. For any other motor, the thermocouple is to be applied on the outer surface of a wrap that is not more than 1/32 inch (0.8 mm) thick and consists of cotton, paper, rayon, or similar materials.

60.1.10 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). Whenever referee temperature measurements by thermocouples are required, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument are to be used. The thermocouple wire is to conform with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

60.1.11 When using the resistance method, the windings are to be at room temperature at the start of the test, and the temperature rise of a winding is to be calculated using the formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

ΔT is the temperature rise in °C,

R is the resistance of the coil in ohms at the end of the test,

r is the resistance of the coil in ohms at the beginning of the test

k is 234.5 for copper and 225.0 for electrical conductor grade (C) aluminum; values of the constant for other conductors are to be determined,

t_1 is the temperature in °C of the coil at the time resistance "r" is being measured, and

t_2 is the room temperature in °C at the time resistance "R" is being measured.

60.2 Maximum normal load

60.2.1 Maximum normal load is determined to be the load that approximates as closely as possible the most severe conditions of intended use. It is not a deliberate overload except as the conditions of actual use are somewhat more severe than the maximum load conditions that are specified by the manufacturer of the product. A product having features not contemplated in these test procedures may be tested as required to meet the intent of these requirements.

61 Dielectric Voltage-Withstand Test

61.1 A pump shall withstand for 1 minute without breakdown the application of a 60-hertz primarily sinusoidal potential between:

a) Live parts and dead metal parts;

b) Circuits that operate at different potentials and are not electrically connected; or

c) Live parts of opposite polarity.

for a test on a capacitor as specified in 61.2(b), with the product at the maximum operating temperature reached during intended use.

61.2 The potential for the test described in 61.1 is to be:

a) One thousand volts for a pump employing a motor rated 1/2 horsepower (373 watts output) or less and 250 volts or less;

b) One thousand volts plus twice the rated voltage for a pump employing a motor rated at more than 1/2 horsepower or more than 250 volts; or

c) One thousand volts plus twice the rated voltage between the terminals of a capacitor used for radio-interference elimination or arc suppression.

61.3 The test potential for the secondary circuit of a product employing a transformer shall be:

a) One thousand volts plus twice the operating voltage when the secondary operates at 251 – 600 volts;

b) One thousand volts when the secondary operates at 51 – 250 volts; or

c) Five hundred volts when the secondary operates at 50 volts or less.

Exception: This does not apply when the secondary circuit is supplied from a Class 2 transformer.

61.4 To determine whether a product complies with the requirements in 61.1 – 61.3, the product is to be tested by means of a 500 volt-ampere or larger transformer, having an output voltage that is primarily sinusoidal and is capable of being varied. 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 rapid as consistent with its value being correctly indicated by a voltmeter.

Exception: A 500 volt-ampere or larger capacity transformer is not required to be used when the transformer is provided with a voltmeter to measure directly the applied output potential.

61.5 When the secondary circuit is grounded at one or more points, the grounding points are to be removed for the test covered in 61.3 and 61.4.

62 Grounding Continuity Test

62.1 The resistance between the point of connection of the equipment-grounding means at or within the product and any other point in the grounding circuit of the product shall not be more than 0.1 ohm.

62.2 Determination of whether the product complies with the requirement in 62.1 is to be made by an ohmmeter or similar test equipment, except that when results that do not comply with the requirements in 62.1 are observed, an alternating current of 20 amperes or more from a power supply of 12 volts or less is to be passed from the point of connection of the equipment grounding means to the metal part in the grounding circuit, and the resulting drop in potential is to be measured between the 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.

63 Rain Test

63.1 A product intended for outdoor use is to be conditioned as described in 63.3. There shall be no obvious wetting of any electrical component, and no water shall enter a compartment that houses field-installed wiring. Following the test, the product shall comply with the requirements of the Dielectric Voltage Withstand Test, Section 61, and the Insulation Resistance Test, Section 66.

63.2 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as illustrated in Figure 63.1. The spray heads are to be constructed in accordance with the details illustrated in Figure 63.2. The water pressure for all tests is to be maintained at 5 psig (34.5 Pa) at each spray head. The distance between the center nozzle and the product is to be 5 feet (1.5 m). The product is to be brought into the focal area of the three spray heads in such a position and under such conditions that result in the entrance of water into the enclosure. The spray is to be directed at a 45 degree angle to the vertical toward the product. The total exposure is to be for 1 hour.

63.3 With reference to the test described in 63.2;

a) The product may be operated in various positions or under various modes of operation or

b) More than one sample may be tested

when alternate modes are possible. The product is to be de-energized when such a condition is capable of leading to more adverse conditions.