UL 574

STANDARD FOR SAFETY

Electric Oil Heaters

UL Standard for Safety for Electric Oil Heaters, UL 574

Eighth Edition, Dated August 14, 2003

Summary of Topics

This revision of ANSI/UL 574 dated October 3, 2024 includes updates to align with the UL Style Manual; 2.1.1, 2.1.2, 2.1.3, 2.1.5, 2.3.2, and Appendix A.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 23, 2024.

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Standard for Electric Oil Heaters

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This ANSI/UL Standard for Safety consists of the Eighth edition including revisions through October 3, 2024.

The most recent designation of ANSI/UL 574 as an American National Standard (ANSI) occurred on October 3, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 574 on April 7, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electric oil heaters for use with Nos. 5 and 6 fuel oil as defined in Specifications for Fuel Oils, ASTM D396, or other oils such as heat transfer oils. Electric oil heaters are to be used in ordinary locations and installed in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover electric oil heaters rated at more than 600 volts.

2 General

2.1 Components

2.1.1 A component of a product covered by this Standard shall:

a) Comply with the requirements for that component as specified in this Standard;

b) Be used in accordance with its rating(s) established for the intended conditions of use; and

c) Be used within its established use limitations or conditions of acceptability.

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;

b) Is superseded by a requirement in this standard; or

c) Is separately evaluated when forming part of another component, provided the component is used within its established ratings and limitations.

2.1.3 *Deleted*

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 A component that is also intended to perform other functions such as overcurrent protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

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 Referenced publications

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

2.3.2 The following publications are referenced in this Standard:

ASME B1.20.1, *Standard for Pipe Threads, General Purpose, Inch*

ASME B36.10, *Welded and Seamless Wrought Steel Pipe*

ASTM D396, *Specifications for Fuel Oils*

ASTM D471, *Test Method for Rubber Property – Effects of Liquid*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

NFPA 70, *National Electrical Code*

UL 157, *Gaskets and Seals*

UL 486A-486B, *Wire Connectors*

UL 873, *Electrical Temperature-Indicating and -Regulating Equipment*

UL 60730-1, *Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements*

CONSTRUCTION

3 Assembly

3.1 The construction of an oil heater shall be such that parts can be reassembled in the intended manner after being dismantled to the extent needed for servicing.

3.2 The location and mounting of any integral controls shall be such as to protect these components from damage in service and when the oil heater is dismantled to the extent needed for servicing.

3.3 An automatic mechanism shall be provided with an enclosure to reduce the risk of unintentional obstruction of moving parts.

3.4 A brazing material for joining liquid-confining parts shall have a melting point (solidus temperature) not less than 1000°F (538°C).

3.5 Screws and nuts used to attach operating parts to movable members shall be upset or otherwise locked to prevent loosening under the conditions of actual use.

3.6 Uninsulated high-voltage live parts shall be provided with an enclosure.

3.7 Unreinforced flat surfaces of an electrical enclosure of cast metal shall be not less than 1/8 inch (3.2 mm) thick, except that malleable iron may be not less than 3/32 inch (2.4 mm) thick and die-cast metal may not be less than 5/64 inch (2.0 mm) thick.

3.8 To conform to 3.7, corresponding thickness of not less than 3/32, 1/16, and 3/64 inch (2.4, 1.6, and 1.2 mm, respectively) may be acceptable when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape and/or size of the surface is such that equivalent mechanical strength to that provided by the basic thickness is obtained.

3.9 An electrical enclosure of sheet metal is judged with respect to its size, shape, thickness of metal, and its suitability, considering the intended use of the complete oil heater. Sheet steel having a minimum thickness of less than 0.026 inch (0.66 mm) when uncoated or 0.029 inch (0.74 mm) when galvanized, or nonferrous sheet metal having a minimum thickness of less than 0.036 inch (0.91 mm), shall not be used except for small areas or for surfaces which are curved or otherwise reinforced to provide mechanical strength equivalent to that provided by the basic thickness.

3.10 Sheet metal to which conduit or metal-clad cable connection is to be made shall be of such thickness or shall be so formed or reinforced that it will have a stiffness not less than that of an uncoated flat steel sheet having an average thickness not less than 0.032 inch (0.81 mm).

3.11 Pipe threads shall be in accordance with the Standard for Pipe Threads, General Purpose, ANSI/ASME B1.20.1. An assembly for attachment to pipe by threaded connection shall have a section intended to serve as a wrench grip.

3.12 An assembly for attachment to pipe larger than 3 inch (76.2 mm) nominal pipe size (Welded and Seamless Wrought Steel Pipe, ANSI B36.10M-2000) shall be provided with standard flanged-pipe connections. Flanges shall conform to the appropriate American National Standard for Pipe Flanges and Flanged Fittings covering the material from which they are made.

3.13 A ferrule, bushing, or other functional part of a heater having a threaded connection for attachment to pipe shall, by inherent design, be prevented from loosening or becoming dislodged as the result of the turning effect of assembly or dismantling pipe.

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

3.15 A spring shall be guided and arranged to prevent binding, buckling, or other interference with its free movement. When necessary, ends of a spring shall be closed and squared.

4 Materials

4.1 A part in contact with oil shall be resistant to the action of such liquid.

4.2 A material, except a seal ring or gasket, shall have a melting point (solidus temperature) of not less than 950°F (510°C) and a tensile strength not less than 10,000 pounds per square inch (psi) (6.9 MPa) at 400°F (204°C).

4.3 A synthetic rubber part in contact with oil shall not show excessive volume change, when considered on the basis of its intended function, following immersion for 70 hours in IRM oil No. 903 (Test Method for Rubber Property – Effects of Liquid, ASTM D471-1998).

4.4 A change in volume of not more than 25 percent swelling or 1 percent shrinkage is considered as indicating compliance with 4.3. See Volume Change Test, Section 18.

4.5 A part made of synthetic rubber which may be affected by aging shall not crack or show visible evidence of deterioration following air oven aging. The test time and temperature should be determined using the oven aging table in the Standard for Gaskets and Seals, UL 157, based on a service temperature as measured during the Temperature Test, Section 17.

4.6 An automatically actuated part of an oil heater shall be made of metal resistant to corrosion or of metal protected by a corrosion resistant finish that will not be impaired by exposure, wear, and the like, during the expected service life of the heater.

4.7 Any sheath, capillary, well, or other part shall be resistant to atmospheric corrosion and attack by the oil it may normally contact in service when failure of the part may permit external leakage or result in hazardous operation of the heater.

4.8 Uncoated ordinary-ferrous materials are considered adequate for the preceding when made of sheet metal not less than 0.053 inch (1.35 mm) thick or made of cast metal not less than 1/8 inch (3.2 mm) thick. Brass alloys in sheet form are not considered resistant to the corrosive effects of fuel oils.

4.9 Cadmium plating shall have a thickness of not less than 0.0003 inch (0.008 mm) and zinc plating shall have a thickness of not less than 0.0005 inch (0.013 mm), except on parts where threads constitute the major portion of the area, in which case the thickness of the cadmium or zinc plating shall be not less than 0.00015 inch (0.0038 mm).

4.10 A part made of drawn brass or machined from brass rod shall be capable of withstanding, without cracking, the 10-Day Moist Ammonia-Air Stress Cracking Test, Section 19.

4.11 If warping of a casting can affect the tightness of liquid-confining joints or the necessary fit of parts, the casting shall be stress-relieved to reduce the possibility of warping to a minimum.

4.12 For flat flanges, a plant-fiber gasket shall be not more than 1/32 inch (0.8 mm) thick. Synthetic rubber gasket shall have a thickness of not less than 1/16 inch (1.6 mm) nor more than 3/32 inch (2.4 mm).

5 Thermal Insulation

5.1 Thermal insulation, except for glass wool or other material having equivalent flammability and absorption resistance, shall not make direct contact with uninsulated live parts of an oil heater.

6 Supply Connections

6.1 Supply connections are considered to be those made in the field when a heater is installed. See 1.1.

6.2 An oil heater shall have provision for the connection of metal-clad cable or conduit.

6.3 An oil heater shall be provided either with wiring terminals or with leads for the connection of conductors having an ampacity (current-carrying capacity in amperes) that complies with the National Electrical Code, ANSI/NFPA 70, and is not less than the current rating of the heater.

6.4 A wiring terminal shall be provided either with a soldering lug firmly bolted or held by a screw or with a pressure wire connector, except that a wire binding screw may be employed at a wiring terminal for the connection of a 10 AWG (5.3 mm^2) or smaller conductor when upturned lugs or the equivalent are provided to hold the wire in position.

6.5 Upturned lugs or a cupped washer, when employed, shall be capable of retaining a 14 AWG (2.1 mm^2) or larger conductor under the head of the screw or washer, even though the screw becomes slightly loose.

6.6 A wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces.

6.7 When a screw and washer construction is employed at a wiring terminal, the wire binding screw shall be not smaller than No. 10 (4.8 mm diameter); except that a No. 8 screw (4.2 mm diameter) may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm diameter) screw may be used for the connection of a 16 AWG (1.3 mm^2) or 18 AWG (0.82 mm^2) control circuit conductor.

6.8 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick for a 14 AWG (2.1 mm^2) or smaller wire, and not less than 0.050 inch (1.27 mm) thick for a wire larger than 14 AWG. In either case there shall be not less than two full threads in the metal, unless a lesser number of threads results in a connection in which the threads will not strip with tightening torques applied in accordance with the values indicated in the Standard for Wire Connectors, UL 486A-486B.

6.9 A terminal plate formed from stock having the minimum required thickness may have the metal extruded at the tapped hole for the binding screw to provide two full threads.

6.10 An oil heater provided with wiring terminals or leads and rated at 125 volts or 125/250 volts or less and employing a lamp or element holder of the screw shell type, a single-pole switch, or a single-pole automatic control; shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. This terminal or lead shall be the one which is connected to screw shells of lamp or element holders, and to which no single-pole switches or single-pole automatic controls are connected.

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

6.12 A lead intended for connection of a grounded supply conductor shall be finished to show a white or grey color, shall be distinguishable from the other leads, and no other lead shall be so identified.

7 Internal Wiring

7.1 General

7.1.1 An enclosure which houses wires or cords shall be smooth and free from sharp edges, burrs, fins, and moving parts that could damage wiring.

7.1.2 Holes in walls or partitions through which insulated wires or cords pass and on which they may bear shall be provided with smoothly rounded bushings or shall have smooth, rounded surfaces to prevent abrasion of the insulation. Bushings, where required, shall be ceramic, phenolic, cold-molded composition, fiber, or equivalent material.

7.1.3 Insulated wires may be bunched and passed through a single opening in a metal wall within an enclosure of the appliance.

7.1.4 A bare conductor or a conductor utilizing beads for insulation shall not be used outside an enclosure.

7.1.5 All splices and connections shall be mechanically secure and bonded electrically. A soldered connection shall be made mechanically secure before being soldered.

7.1.6 A splice shall be provided with insulation equivalent to that of the wires involved.

7.1.7 Splicing devices, such as fixture-type splicing connectors or pressure wire connectors, may be employed when they provide mechanical security and employ insulation rated for the voltage to which they are subjected. In determining when splice insulation consisting of coated fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as its electrical, mechanical, and flammability properties. Thermoplastic tape wrapped over a sharp edge is unacceptable.

7.1.8 Splices shall be located, enclosed, and supported so that they are not subject to damage, flexing, motion, or vibration.

7.2 Bonding for grounding

7.2.1 Except as noted in 7.2.2, all exposed dead-metal parts shall be in electrical connection with the grounding means at the point of connection of the power supply wiring system.

7.2.2 The requirement in 7.2.1 does not apply to:

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

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

2) Positively separated from all electrical components.

b) A panel or cover that is insulated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture resistant insulating material no less than 30 mils (0.008 mm) in average thickness, 28 mils (0.007 mm) minimum acceptable thickness at any point, and reliably secured in place.

c) A panel or cover that does not enclose uninsulated live parts and is positively separated from other electrical components.

7.2.3 Unless the dead-metal parts described in 7.2.1 are bonded together by mechanical fasteners, an individual bonding conductor or strap shall be used for this purpose.

7.2.4 The bonding conductor shall be of material rated for use as an electrical conductor, of adequate size, and protected from corrosion unless inherently resistant thereto. An individual bonding conductor or strap shall be installed so that it is protected from physical damage.

7.2.5 The bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, brazing, or welding. The bonding connection shall penetrate nonconductive coatings such as paint.

7.2.6 The size of an individual conductor or strap employed for bonding shall be determined by the rating of the branch-circuit overcurrent device to which the oil heater is to be connected in accordance with Table 250-122 of the National Electrical Code, ANSI/NFPA 70.

7.2.7 When the adequacy of a bonding connection cannot be determined by examination, or when a bonding conductor is smaller than required by 7.2.6, it shall be acceptable when the bonding connection does not open when carrying for two minutes twice the current equal to the rating of the branch-circuit overcurrent device.

7.2.8 The resistance of the grounding path between a dead-metal part and the equipment grounding terminal or point of attachment of the wiring system shall be no more than 0.1 ohm.

7.2.9 With reference to 7.2.8, the resistance may be determined by any convenient method. When unacceptable results are recorded either a direct or alternating current, equal to the current rating of the maximum current-rated branch-circuit overcurrent protective device that may be employed with the heater, is to be passed at a potential of no more than 12 volts from the equipment grounding terminal, or the point of attachment of the wiring, to the dead-metal part. The resulting drop in potential is to be measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

8 Electrical Insulation

8.1 Insulating washers, bushings, and similar parts, which are integral parts of an oil heater, and bases or supports of the mounting of current carrying parts shall be of a moisture resistant material, such as porcelain, phenolic, or cold-molded composition which will not be damaged by the temperatures to which they will be subjected under conditions of actual use. See Temperature Tests, Section 17. Materials such as mica, some molded compounds, and certain refractory materials may also be rated for use as the sole support of uninsulated live parts.

8.2 In the mounting or supporting of small, fragile insulating parts, screws or other fastenings should not be tight enough to result in the cracking or breaking of these parts as a result of expansion and contraction. Generally, such parts should be slightly loose.

9 Overload Protection

9.1 A fuseholder or circuit breaker provided as a part of a heater shall not be accessible from the outside of the oil heater without opening a door or cover, except that the operating handle of a circuit breaker may project outside of the enclosure. A plug-fuseholder shall be installed so that uninsulated live parts other than the screw shell and center contact will not be exposed to contact by persons removing or replacing fuses.

9.2 An oil heater rated more than 48 amperes and employing resistance heating elements shall have the heating elements on subdivided circuits. Each subdivided load shall not exceed 48 amperes and shall be protected at no more than 60 amperes.

Exception: An oil heater employing a resistance type immersion electric heating element contained in a vessel marked with an appropriate ASME symbol may be subdivided into circuits not exceeding 120 amperes and protected at no more than 150 amperes.

9.3 The overcurrent protection devices required in 9.2 shall be provided by the manufacturer as an integral part of the oil heater or shall be provided by the manufacturer as a separate assembly for independent mounting for use with the oil heater. When the overcurrent protection devices are provided as a separate assembly, the oil heater and the overcurrent protection assembly shall be marked as required in 26.14 and 26.15, respectively.

9.4 The overcurrent protection specified in 9.2 and 9.3 shall be of a type rated for branch circuit protection. A cartridge fuse used for this purpose shall be a Class CC, G, H, J, K, R, T, or equivalent fuse meeting the requirements for branch circuit protection. A plug fuse shall be used only in circuits of 125 volts maximum.

10 Lampholders

10.1 When an oil heater is intended to be connected to the identified (grounded) conductor of a power-supply circuit, a lampholder supplied as a part of the heater shall be so wired that the screw shell will be connected to that conductor.

10.2 A lampholder shall be so installed that uninsulated live parts, other than the screw shell and center contact, will not be exposed to contact by persons removing or replacing lamps in service.

Exception: This requirement may be waived when, in order to remove or replace a lamp, it is necessary to dismantle the oil heater by means of tools.

11 Switches

11.1 A switch provided as a part of an oil heater shall have a current and voltage rating not less than that of the circuit (load) which it controls.

11.2 A switch subjected to a temperature higher than 149°F (65°C) will be subjected with respect to the temperature limitations of the materials employed.

11.3 A manually operated switch controlling one or more elements of a heater shall be arranged so that the opening of the switch will disconnect all the ungrounded conductors of the supply circuit, unless there are no exposed live parts when the switch is open, or unless the fact that such parts are live is apparent.

11.4 A switch or other means of control intended to permit the use of a limited number of elements at one time shall be so located or of such a type that the connections cannot be changed to permit the use of more elements than intended.

12 Controls

12.1 A control or protective device shall interrupt the ungrounded conductors.

12.2 A control or protective device shall have a current and voltage rating not less than that of the circuit (load) which it controls.

12.3 A control circuit shall be arranged so that it may be connected to a power supply branch circuit equipped with overcurrent protection at the value appropriate for the rating of any control included in the circuit.

12.4 A control shall be accessible.

12.5 A control shall be supported in such a manner that it and its sensing element will remain in the intended position.

12.6 Nothing shall be provided for the purpose of permitting any control to be rendered ineffective.

12.7 A control for limiting or regulating temperature shall, when adjustable, be provided with a maximum operating temperature position in the form of a "stop" on the dial or the equivalent. A graduated dial or other means such as the use of arrows indicating the method of adjusting the operating temperature of a control shall be provided. See 26.10.

12.8 The maximum adjustable setting of a temperature control shall be limited to approximately 250°F (121°C).

Exception: The maximum temperature setting for a heater used with oils other than No. 5 and 6 fuel oils may exceed 250°F (121°C) provided the maximum temperature setting does not exceed the flash point and the oil manufacturer's maximum recommended temperature, and the product is marked as described in 26.13.

12.9 When an assembly includes more than one control, such as an auxiliary or limiting control, in addition to a temperature control, each control shall be identified as to its function on the outside of the assembly. See 26.9.

12.10 Any auxiliary control device shall be rated in volts; and also in horsepower and/or amperes, volt-amperes, or watts; and may be rated for alternating current only. When such a control is intended to control solenoid loads, it shall be rated in volts and volt-amperes pilot duty.

12.11 When an auxiliary control is intended for the control of a motor rated at 2 horsepower (1492 W output) or less, it may have a combination current rating which includes both full-load and stalled-rotor motor currents.

12.12 With reference to the requirements of 12.7 – 12.11:

a) A temperature-regulating control is considered to be one which functions only to regulate the temperature of the oil to be heated under intended conditions of use.

b) A temperature-limiting control is considered to be one which functions only under conditions which produce abnormal temperatures. The impaired operation of such a control might or might not result in a risk of fire.

c) An auxiliary control is considered to be one which functions as the result of a change in the temperature of the oil at a specific location and which acts as an interlock for governing operation of a liquid-handling or liquid-burning device.

13 Mounting of Components

13.1 A switch, fuseholder, lampholder, or similar electrical component shall be mechanically secured and shall be prevented from turning.

13.2 The means for preventing turning is to consist of more than friction between surfaces but a lock washer is acceptable as the means for preventing a small stem-mounted switch or other small device having a single-hole mounting means from turning.

Exception: The requirement that a switch be prevented from turning may be waived, when all three of the following conditions are met:

a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during operation of the switch.

b) The spacings are not reduced below the minimum required values when the switch rotates.

c) The operation of the switch is by mechanical means rather than by direct contact by persons.

13.3 A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning when rotation cannot reduce spacings below the minimum required values.

13.4 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, when such motion may result in a reduction of spacings below the required values.

SPACINGS

14 General

14.1 Exclusive of a control, or other component device, such as a switch, lampholder, and similar devices, supplied as part of an oil heater, the spacings shall be not less than those indicated in Table 14.1. See 2.1.

Table 14.1
Minimum spacings

Parts other than terminals		Potential involved, volts			
		0 – 250		251 – 600	
		inch	(mm)	inch	(mm)
Between any uninsulated live parts of opposite polarity, and between any rigidly mounted uninsulated live part and metal which may be exposed to contact by persons during the operation of the heater or which may be grounded.	Through air or oil	1/16[a,b,c]	1.6[a,b,c]	1/4[c]	6.4[c]
	Over surface	1/16[a,b,c]	1.6[a,b,c]	1/4[c]	6.4[c]
For wiring terminals of supply connections (not applicable to connecting straps or buses which extend away from terminals): between a wiring terminal and metal of the enclosure.	Through air	1/2	12.7	1/2	12.7
Between terminals of opposite polarity or between live terminal parts and metal other than the enclosure which may be grounded in service.	Through air	1/4	6.4	3/8	9.5
	Over surface	3/8	9.5	1/2	12.7

[a] When an uninsulated live part is not rigidly supported, or when a movable dead metal part is in proximity to an uninsulated live part, the construction is to be such that the minimum spacing of 1/16 inch (1.6 mm) will be maintained under all operating conditions.

[b] At closed-in points only, such as the screw and washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) is to be considered acceptable.

[c] Enamel-insulated wire is regarded as an uninsulated live part when spacings are considered.

14.2 The electrical spacings in a device, such as a control relay and similar devices, supplied as part of an electric oil heater shall comply with the requirements of the Standard for Electrical Temperature-Indicating and -Regulating Equipment, UL 873. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

14.3 An insulating lining or barrier of fiber or similar material employed where spacings would otherwise be insufficient shall be not less than 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it will not be adversely affected by arcing.

Exception: Fiber not less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone. Unless protected from damage during assembly and intended functioning of the heater, a barrier of mica shall be 0.01 inch (0.25 mm) or more in thickness.

PERFORMANCE

15 Power Input Test

15.1 The power input to an oil heater shall be not more than 105 percent of its marked rating.

15.2 Power input is to be measured with the heater at the intended operating temperature under full-load conditions and while connected to a supply circuit of rated voltage.

15.3 The rated voltage of a heater, for purposes of testing, is considered to be 120 volts, or a multiple of 120 volts, for a marked voltage range of 110 – 120 volts, or a multiple of 110 – 120 volts. When a rating of a heater does not fall within these ranges, such as 208 volts, the marked voltage rating will be used as the test voltage.

16 Insulation Resistance Test

16.1 Insulating material shall have an insulation resistance of not less than 50,000 ohms after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 89.6 ±3.6°F (32 ±2°C). See also 8.1.

16.2 Insulation resistance is to be measured by means of a high-resistance voltmeter, using a 250 volt, direct-current circuit.

17 Temperature Tests

17.1 Normal operation test

17.1.1 An electric oil heater shall not attain a temperature at any point sufficiently high as to damage any material employed in the heater, nor show temperature rises at specific points exceeding those indicated in Table 17.1.

17.1.2 All values in Table 17.1 are based on an assumed ambient temperature of 77°F (25°C); however, tests may be conducted at any ambient temperature within the range of 50 – 104°F (10 – 40°C).

17.1.3 Temperature readings are to be obtained by means of thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2). A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minute intervals, indicate no change.

Table 17.1
Maximum temperature rises

Materials and component parts		Degrees C	Degrees F
1.	Rubber and thermoplastic-insulated conductors[a,b]	35	63
2.	Varnished-cloth-insulated conductors	60	108
3.	Conductors having slow-burning insulation	65	117
4.	Points within a terminal box or compartment	65	117
5.	Fuses	65	117
6.	Fiber used as electrical insulation	65	117
7.	Class 105 insulation on coil windings[c]	65	117
8.	Class 130 insulation on coil windings[c]	85	153
9.	Phenolic composition used as electrical insulation or as other part whose failure would result in a hazardous condition[a]	125	225
10.	Sealing compound	72°F (40°C) less than the melting point (maximum, not rise)	

Table 17.1 Continued on Next Page

Table 17.1 Continued

Materials and component parts	Degrees C	Degrees F
[a] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds which have been investigated and found to have special heat resistant properties. [b] Inside the heater, the jacket of a rubber-jacketed cord may be subjected to a temperature rise of more than 63°F (35°C) if: 1) The individual conductors of the cord are provided with a rayon or cotton braid or sleeving, the temperature rise on the braid or sleeving is not more than 117°F (65°C), and a sleeving is prevented from unraveling by a wrap of friction tape or other equivalent means or 2) Other acceptable means, such as close-fitting tubing recognized for the temperature involved, is provided to protect the insulation on the individual conductors. [c] For Class 105 insulation on coil windings, a temperature rise of 153°F (85°C), as measured by the resistance method, is acceptable; and for Class 130 insulation on coil windings a rise of 171°F (95°C) is acceptable.		

17.1.4 Thermocouples used in the determination of temperatures in connection with the heating of electrical devices, or whenever referee temperature measurements are necessary, are to consist of 30 AWG (0.05 mm^2) iron and constantan wires. A potentiometer-type of indicating instrument is to be employed. The thermocouple wire shall conform to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

17.1.5 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in thermal contact with the surface of the material whose temperature is being measured. In most cases, thermal contact will result from taping or cementing the thermocouple in place; but when a metal surface is involved, brazing or soldering the couple to the metal may be necessary.

17.1.6 An oil heater is to be connected to a supply circuit of rated voltage except when rated within the ranges indicated in Table 17.2. When rated voltage is within the ranges indicated in Table 17.2, the designated test voltages are to be applied. When the wattage input to the heater when so connected is less than the marked wattage rating, the test voltage is to be adjusted to cause the wattage input to be not less than the marked input.

Table 17.2
Test voltages

Nameplate voltage rating	Normal test voltage
110 to 120	120
208	208
220 to 240	240
254 to 277	277
440 to 480	480
550 to 600	600
Other	Rated

17.1.7 In determining when an oil heater complies with the requirements of 17.1.1, actual service conditions or an approximation thereof are to be employed. An oil heater is to be tested in a reservoir or piping system similar to that for which it is intended. Liquid of the kind or kinds for which it is intended is to be allowed to flow through the reservoir or piping at various rates consistent with the heating capacity of the device and also maintained in the reservoir or piping under no-flow conditions.

17.1.8 When a heater is controlled by an adjustable control, the control is to be set to give maximum temperatures. When a heater is controlled by a nonadjustable control, it is to be allowed to operate at

whatever temperature the control permits. When a heater is not provided with a temperature control, the temperature of the liquid in the reservoir or piping under both flow and no-flow conditions is to be maintained by manual control of the electrical input at the maximum temperature of the liquid recommended by the manufacturer. In all cases, including heaters without controls, operation is to be continued until temperatures are stabilized.

17.1.9 For a device provided with an automatic operating control, the measured temperature rises on the various electrical components may exceed the values in Table 17.1 by not more than 27°F (15°C) during the initial period of energization of the oil heater in which the oil is heated from room temperature to the initial operation (opening) of the control. Thereafter, maximum steady-rate temperatures are not to exceed the values in Table 17.1.

17.2 Abnormal operation test

17.2.1 When operated under abnormal conditions, a heater shall not emit flame or molten metal or the operation of the heater shall not cause glowing or flaming of combustible material which may be in proximity to the device as installed.

17.2.2 A separate burnout or abnormal heating test is to be conducted with the heater operating continuously until the ultimate result has been determined. In most cases, continuous operation for 7 to 8 hours will be necessary in order to make sure that the ultimate result has been observed.

17.2.3 Drops of melted solder are not considered to be molten metal with respect to the provisions of 17.2.1.

17.2.4 The test is to be conducted with the applied voltage and method of mounting as described in 17.1.6 and 17.1.7.

17.2.5 The oil heater is to be operated dry with any automatic temperature controls or protective devices remaining in the circuit. The dry condition is to be obtained by draining liquid from the reservoir or piping employed for the Normal Operation Test. Residual liquid retained following intended methods for draining is to remain in the reservoir or piping.

18 Volume Change Test

18.1 The volume change test described in 4.4 is to be conducted in a manner similar to that described in Standard Test Method for Rubber Property, Effect of Liquids, ASTM D471-1998, with variations as noted.

18.2 The test is conducted at a temperature of 73.4 ±3.6°F (23 ±2°C). Three specimens are used in the test. Each specimen is placed on a small diameter wire hook. Its volume is then determined by weighing first in air (M_1) and then in water (M_2). The specimens are then wiped dry and placed in the test liquid. After 70 hours, the specimens are to be removed from the liquid one at a time, immediately wiped dry, and weighed in air while on the same hook (M_3). The weight is to be obtained within 30 seconds after removal from the test liquid. The final weight in water (M_4) is to be determined immediately thereafter. Before obtaining the weights in water (M_2 and M_4), each specimen is to be dipped in ethyl alcohol, then dipped in water, in order to eliminate surface air bubbles. The change in volume is to be calculated as follows with the results reported as the average of the three specimens tested:

$$Volume\ Change\ (percent) = \frac{(M_3 - M_4) - (M_1 - M_2)}{(M_1 - M_2)} \times 100$$