UL 647

Underwriters Laboratories Inc.

Standard for Safety

# Unvented Kerosene-Fired Room Heaters and Portable Heaters

UL Standard for Safety for Unvented Kerosene-Fired Room Heaters and Portable Heaters, UL 647

Second Edition, Dated May 3, 1993

***Summary of Topics***

***These revisions to UL 647 are being issued to address universal upkeep of UL Standards for Safety. These revisions are considered to be non-substantive and not subject to UL's STP process.***

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. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

A reference to UL 60730-1 and/or a Part 2 standard from that series has been added to this standard. The addition of this reference provides an alternate standard for investigating components currently covered by UL 873 until October 19, 2016. This added reference will facilitate the use of components that have been investigated to the UL 60730 series. Such components have been determined to fulfill the requirements of the legacy standards.

UL 60730-1 (4th Edition) becomes effective on October 19, 2016. All components that were previously investigated to the requirements in UL 873 will have to comply with the requirements in either UL 60730-1 and/or a Part 2 standard from that series in order to maintain UL Listing or Recognition, as appropriate. UL 873 legacy control standard will be withdrawn on October 19, 2016.

This is intended to provide end product manufacturers with sufficient time to a) address the impact of the standards changes during normal design changes over the intervening years, b) submit any modified products for investigation, and c) implement any necessary changes in production.



The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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**MAY 3, 1993**
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**1**

# UL 647

## Standard for Unvented Kerosene-Fired Room Heaters and Portable Heaters

First Edition – December, 1982

**Second Edition**

**May 3, 1993**

This UL Standard for Safety consists of the Second Edition including revisions through April 16, 2010.

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 http://csds.ul.com.

No Text on This Page

## CONTENTS

## INTRODUCTION



## CONSTRUCTION

GENERAL

ELECTRICAL COMPONENTS



SPACINGS



**PERFORMANCE**

**MANUFACTURING AND PRODUCTION TESTS**



**MARKING**



**APPENDIX A**

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## INTRODUCTION

### 1 Scope

1.1 These requirements apply to unvented kerosene-fired room heaters and portable heaters as defined herein. They are for use with Type 1-K Kerosene, and Synthetic Fuels complying with the Outline of Investigation for Synthetic Fuels for Listed Kerosene-Fired Portable Heaters and Kerosene-Fired Room Heaters, Subject 647A, in spaces that are well ventilated to provide the supply of air required for combustion and to reduce the risk of accumulation of carbon monoxide. These heaters are for attended or unattended use. These products are required to be equipped with automatic primary safety controls or to be inherently constructed to prevent abnormal discharge of fuel at the burner in case of ignition failure or premature flame extinguishment. They are not intended for use under the following conditions:

a) In spaces in which flammable vapors or gases may be present, or

b) As cooking appliances.

1.1 revised April 16, 2010

1.2 Requirements for the installation and use of kerosene-fired room heaters and portable heaters are included in the Standard for the Installation of Oil-Burning Equipment, NFPA 31 and in codes such as the BOCA National Mechanical Code, the SBCC Standard Mechanical Code, and the ICBO/IAPMO Uniform Mechanical Code.

1.3 The maximum fuel-input rating for kerosene-fired room heaters is 30,000 Btu per hour (31.65 MJ) and for kerosene-fired portable heaters is 25,000 Btu per hour (26.38 MJ).

1.4 These requirements cover kerosene-fired room heaters and portable heaters that may include electrical circuits rated 600 volts or less and are intended for installation as specified in the National Electrical Code, NFPA 70.

*1.5 Deleted July 27, 2001*

### 2 General

2.1 The term heater refers to all products covered by this standard unless specifically noted otherwise.

2.1.1 The term fuel refers to both Type 1-K Kerosene and Synthetic Fuels for all products covered by this standard, unless specifically noted otherwise.

2.1.1 added November 2, 1998

2.2 Except as indicated in 2.3, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

2.2 revised July 27, 2001

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

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

b) Is superseded by a requirement in this standard.

2.3 revised July 27, 2007

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

2.4 revised July 27, 2001

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

2.5 revised July 27, 2001

2.6 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.

2.6 revised July 27, 2001

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

2.7 revised July 27, 2001

## 3 Installation And Operating Instructions

3.1 A copy of the manufacturer's installation and operating instructions shall be furnished with each heater. These instructions are to be used as a guide in the examination and test of the heater. For this purpose a printed edition is not required.

3.2 The instructions shall include such directions and information as deemed by the manufacturer to be adequate for attaining intended installation, maintenance, and use of the heater. For those heaters that are not intended for use with Synthetic Fuels, the instructions shall indicate that Synthetic Fuels shall not be used with the heater. At least the following information shall be included:

a) Initial setup and operating instructions, including minimum clearances to adjacent flammable materials while the heater is in operation. When further actions are required by the user to:

1) Complete installation of a guard or grille that is folded or telescoped, or

2) Attach a guard or grille that is not attached to the heater at the factory,

they shall be completely described in the instructions.

b) Method of adjustment of the burner flame with detailed instructions for wick-type heaters specifying that the heater should be operated only at the manufacturer's recommended burner settings.

c) When the heater is intended only for use with No. 1-K kerosene, instructions to use only clear or red colored No. 1-K kerosene (see the Specification for Kerosene, ASTM D3699-96). When the heater is intended for use with either kerosene or synthetic fuel, instructions to use only clear or red colored No. 1-K kerosene (see the Specification for Kerosene, ASTM D3699-96) or synthetic fuels for use with kerosene-fired portable heaters. For all heaters, instructions on how to fill the reservoir.

c1) Information that the kerosene in the USA is sometimes dyed red due to tax laws and the red dyed kerosene should be translucent (able to be seen through) and not cloudy.

d) Lighting Instructions – The instructions for heaters equipped with burner mantles that may require manual adjustment shall include details on how to position the mantle as intended in the heater and how to seat the mantle after lighting heater.

e) Maintenance – When the burner is of the wick type, the following shall be included:

1) Identification of the manufacturer or private labeler and part number or equivalent of the recommended replacement wick or wicks.

2) Detailed instructions for wick replacement as follows:

a) Disassembly of the heater to remove old wick.

b) Installation of the replacement wick, including specification for the maximum wick height in millimeters and inches.

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c) Reassembly of the heater.

d) Instructions for the operator to recheck wick height after reassembly and to check that the wick adjuster and extinguishing device are operating as intended before using the heater.

f) The following or equivalent cautionary statement preceded by the word WARNING:

1) Risk of Explosion –

a) Never use any fuel other than the fuels specifically identified for use in the heater. Never use gasoline.

b) Never refill heater fuel tank when heater is operating or still hot.

c) Never fill heater fuel tank in living space. Fill heater tank outdoors.

d) Never use heater in areas where flammable vapors or gas may be present.

e) Never store or transport the fuel in other than a metal or plastic container that is:

1) Acceptable for use with the specific fuel,

2) Nonred in color,

3) For 1-K Kerosene clearly marked, ″kerosene,″ or

4) Is in the original container for the Synthetic Fuel.

f) Never store fuel in the living space.

2) Due to high surface temperatures, keep children, clothing, and furniture away.

3) Risk of Indoor Air Pollution – Use heater only in well-ventilated areas. People with breathing problems should consult a physician before using the heater.

4) Do not use heater to heat or boil water or use as a cooking appliance.

g) The following or equivalent information for provision of combustion and ventilating air for unvented heaters: ″In a house of typical construction, that is, one that is not of unusually tight construction due to heavy insulation and tight seals against air infiltration, an adequate supply of air for combustion and ventilation is provided through infiltration. However, if the heater is used in a small room where less than 200 cubic feet (5.7 $m^3$) of air space is provided for each 1000 Btu per hour of heater rating (considering the maximum burner adjustment), the door(s) to adjacent room(s) should be kept open or a window to the outside should be opened at least 1 inch (25.4 mm) to guard against potential buildup of indoor air pollution. Do not use the heater in a bathroom or any other small room with the door closed.″

h) For a heater that requires further actions by the user to:

1) Attach a disassembled guard or grille, or

2) Complete installation of a guard or grille that is folded or telescoped and is not provided with an interlock that would prevent heater operation unless the guard or grille is attached to the heater in its final intended position,

the following or equivalent cautionary statement preceded by the word ″CAUTION″:

″Risk of burns. Do not operate the heater without the guard or grille completely attached.″

i) Periodic Service – Details on the items that require periodic service, recommended intervals for such service, and instructions for performing the service.

1) The information mentioned in subitems a – g shall be included for all heaters, as applicable.

a) Cleaning of heater combustion surfaces, including the burner glass chimney.

b) Replacement of burner glass chimney when cracked or broken.

c) Adjustment and replacement of ignition device.

d) Cleaning and/or replacement of air filter.

e) Checking operation of external manual shutoff device and tip-over device.

f) Replacement of battery.

g) Preparation of heater for storage.

2) The information mentioned in subitems a and b shall be included for heaters with a wick type burner.

a) Wick replacement.

b) Wick cleaning.

j) For a heater provided with a minimum wick stop in accordance with 14.3(a), the following or equivalent statement preceded by the word ″WARNING″:

″Risk of indoor air pollution and fire. Do not operate heater at wick setting lower than minimum wick-stop setting.″ [See 3.2(b)].″

Revised 3.2 effective July 27, 2002

## 4 Glossary

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

4.2 ANTIFLOODING DEVICE – A primary safety control that causes the fuel flow to be shut off upon a rise in fuel level or upon receiving excess fuel, and that operates before the unintended discharge of fuel can occur. A wick, vacuum breaker, or other automatic device may be considered an antiflooding device.

No Text on This Page

4.3 APPLIANCE FLUE – The flue passages within the heater.

4.4 BAFFLE – An object placed in a heater to direct or to retard the flow of air of flue gases.

4.5 BASE – The main supporting frame or structure of an assembly.

4.6 BURNER – A device for the final conveyance of fuel or a mixture of fuel and air to the combustion zone.

4.7 BURNER, VAPORIZING TYPE – A burner consisting of an oil-vaporizing bowl or other receptacle to which liquid fuel may be fed in controllable quantities with provision for admitting air and mixing it with the fuel vapor in combustible proportions. The heat of combustion is used to vaporize the fuel.

4.8 BURNER, WICK TYPE – A burner consisting of a receptacle and wick to which liquid fuel may be fed in controllable quantities. The wick carries the fuel to the combustion zone where air is introduced for combustion.

4.9 CASING – An enclosure forming the outside of the heater, no parts of which are likely to be subjected to intense heat.

4.10 CATALYST – A material that speeds the oxidation of hydrocarbons and carbon monoxide into water vapor and carbon dioxide.

4.11 COMBUSTIBLE MATERIAL – As pertaining to materials adjacent to or in contact with heaters, a material made of or having surfaces of wood, compressed paper, plant fibers, or other material that will ignite and burn. Such material shall be considered as combustible even though flameproofed, fire-retardant treated, or plastered.

4.12 COMBUSTION – The rapid oxidation of fuel accompanied by the production of heat, or heat and light. Complete combustion of a fuel is possible only in the presence of an adequate oxygen supply.

4.13 COMBUSTION CHAMBER – The portion of the heater within which combustion occurs and that is usually part of the heat exchanger.

4.14 CONSTANT-LEVEL VALVE – A device for maintaining within a reservoir a constant level of fuel for delivery to the burner.

4.15 CONTROL – A device used to regulate the fuel, air, water or electrical supply to the controlled equipment. It may be automatic, semiautomatic, or manual.

4.16 CONTROL, LIMIT – An automatic safety control responsive to changes in liquid level, pressure, or temperature; for limiting the operation of the controlled equipment.

4.17 CONTROL, PRIMARY SAFETY – The automatic safety control intended to prevent abnormal discharge of fuel at the burner in case of ignition failure or premature flame extinguishment.

4.18 DAMPER – A valve or plate for regulating draft or flow of flue gases. A damper is generally considered as being located on the downstream side of the combustion chamber, usually in a flue passage of a heater or in the flue pipe.

4.19 DEVICE, SAFETY – Automatic controls and interlocks (including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety-control system) that are intended to prevent operation of the controlled equipment that could cause a risk of fire, electric shock, or injury to persons.

4.20 ELECTRICAL CIRCUITS:

a) High-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.

b) Low-Voltage Circuit – A circuit involving a potential of not more than 30 volts alternating-current rms (42.4 peak or direct current) and supplied by a primary battery or by a standard Class 2 transformer or other transforming device, or by a combination of transformer and fixed impedance having output characteristics in compliance with what is required for a Class 2 transformer. A circuit derived from a source of supply classified as a high-voltage circuit by connecting resistance in series with the supply circuit as a means of limiting the voltage and current is not considered to be a low-voltage circuit.

c) Isolated-Limited-Secondary Circuit – A circuit of limited energy derived from an isolated secondary winding of a transformer having a maximum capacity of 1000 volt-amperes and open-circuit secondary-voltage rating not exceeding 1000 volts.

d) Safety (Control) Circuit – A circuit involving one or more safety devices.

4.21 EXCESS AIR – Air that passes through the combustion area and the appliance flues in excess of that which is theoretically required for complete combustion.

4.22 FLUE GASES – Combustion products and excess air.

4.23 FULL DRAIN – As applied to tanks, a construction in which the tank is emptied through its normal feed outlet at the bottom of the tank.

4.24 HEATER, CIRCULATING – A room heater intended to convert energy in the fuel to convected heat by the circulation of air heated by contact with the heating surfaces.

4.25 HEATER, DIRECT-FIRED – A heater in which combustion products or flue gases are mixed with the air being heated.

4.26 HEATER, RADIANT – A heater intended primarily to convert energy in the fuel to radiant heat, such as with openings in the outer jacket to permit direct radiation from the heating surface.

4.27 HEATER, ROOM – A stationary, self-contained, freestanding, air-heating appliance intended for installation in the space being heated and not intended for duct connection.

4.28 HEATING SURFACES – All surfaces that transmit heat directly from flame or flue gases to the medium to be heated.

4.29 KEROSENE – A hydrocarbon oil defined by the Standard Specification for Kerosene, ASTM D3699-96. Kerosene is either clear or dyed translucent (i.e. not cloudy) red in color.

Revised 4.29 effective July 27, 2002

4.30 MANUALLY LIGHTED HEATER – A heater in which fuel to the main burner is turned on only by hand and ignited under supervision.

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4.31 PORTABLE HEATER – A direct-fired heater that:

a) Is intended to burn kerosene,

b) Is not flue connected,

c) Can be carried from one location to another,

d) Is self-supporting and self-contained, and

e) Includes either an integral or a removable fuel tank.

4.32 RADIATION SHIELD – A separate panel or panels interposed between heating surfaces and adjacent objects to reduce heat transmission by radiation.

4.33 READILY ACCESSIBLE – Capable of being reached easily and quickly for operation, adjustment, and inspection.

4.34 SAFETY SHUT-DOWN – The action of shutting off all fuel and ignition energy to the burner by a safety control, or controls, such that restart cannot be accomplished without a manual restart.

4.35 SUMP (FOUNT) – The receptacle employed with a vacuum tank.

4.35.1 SYNTHETIC FUEL – A fuel that is the result of a process consisting of refining crude oil in combination with chemical reactions producing a specific liquid fuel meeting the requirements of No. 1-K Kerosene referenced in ASTM D3699-96, Standard Specification for Kerosene.

4.35.1 added November 2, 1998

4.36 TANK, GRAVITY – A fuel tank from which the fuel is delivered directly to the burner by gravity.

4.37 TANK, INTEGRAL – A fuel tank that is permanently attached to a heater.

4.38 TANK, REMOVABLE – A fuel tank that can be separated from a heater, without the use of a tool, for filling.

4.39 TANK VACUUM – A fuel tank that maintains a definite level of fuel in a sump or similar receptacle by barometric feed. Fuel is delivered from the sump to the burner by gravity.

4.40 TRACER FLAME – Small flickers or a trickle of flame at or above the wick of a wick-type burner that may continue to burn due to presence of kerosene vapors after the main burner flame has been extinguished.

4.41 VALVE, FUEL-CONTROL – An automatically or manually operated device consisting essentially of a fuel valve for controlling the fuel supply to a burner.

a) Metering (Regulating) Valve – A fuel-control valve for regulating burner input.

b) Safety Valve – A normally closed valve of the On and Off type (without any bypass to the burner) that is actuated by a primary safety control or by an emergency device.

4.42 VALVE, MANUAL FUEL-SHUTOFF – A manually operated valve in the fuel line for the purpose of completely turning on or shutting off the fuel supply to the burner.

## CONSTRUCTION

GENERAL

### 5 Assembly

5.1 Each heater shall include all the essential components necessary for its intended function when installed as intended.

5.2 The various parts of a heater shall be constructed and assembled in accordance with these requirements to provide the strength, rigidity, and durability required.

5.3 The various parts of a heater shall be assembled or jointed as intended. Soft solder shall not be used on any fuel-handling parts if melting of the solder may allow leakage of fuel, except as indicated in 20.14. Soft-soldered joints, where acceptable, shall be made mechanically secure before soldering.

5.4 The heater shall be completely assembled by the manufacturer before shipment from the factory.

*Exception No. 1: Subassemblies (such as a completely assembled burner or chimney section of a wick-type heater), minor parts, or accessories may be shipped unassembled with clear and precise instructions for their assembly in the field, provided that:*

*a) The heater cannot be operated without correctly installing the parts, subassemblies, or accessories; or*

*b) A risk of fire or injury to persons is not caused when the heater is operated without using the parts, subassemblies, or accessories.*

*Exception No. 2: A tray or subbase that complies with the requirements in 9.2 may be furnished without being assembled on the heater.*

*Exception No. 3: A heater that incorporates a guard or grille may be shipped with the guard or grille unassembled, provided the heater is marked in accordance with 3.2(h).*

5.5 If a functional part of a heater is rendered inoperative (nonfunctional) in the factory by packaging materials used for shipment purposes, the packing materials shall be arranged so that they have to be removed and so that all essential parts, the function of which is required to comply with the requirements in this standard, are functional before the heater can be operated.

5.6 A constant-level valve or sump assembly shall be secured in position and mounted independently of the fuel piping.

5.7 A hinge provided for the joining of the upper and lower sections of a portable heater, together with any latching device, the malfunctioning of which could cause a spillage of fuel or other risk of fire, shall be:

a) Of permanently attached and assembled parts, and

b) Resistant to distortion.

A latch shall engage as intended automatically from the weight of the upper section.

5.8 A bail or carrying handle of a portable heater shall be equivalent in strength and rigidly to steel wire of 0.162-inch nominal diameter. It shall be provided with a nonflammable handle grip arranged to be not closer than 1 inch (25.4 mm) to any heating surface when the bail is at rest and not less than 6 inches (152 mm) from the top of the heater when in the raised position.

5.9 A substantial sheet-metal drip pan or base coated to retard corrosion shall be provided below all burners to retain drippings and char. It shall be an integral part of the heater and shall be readily cleanable.

5.10 If a heater includes a mechanism to extinguish the flame in the event the heater is tipped over, the mechanism shall not include any means external to the heater by which the mechanism can be rendered ineffective. See 56.1.

5.11 A door, guard, or grille that provides access to the burner and that is large enough to permit the burner to fall out during heater tipover shall:

a) Be secured in the closed position by a positive means (for example, by a spring-loaded clip, quarter-turn thumbscrew, or the like) and

b) Comply with the Burner Access Door Securement Test, Section 55, and with 54.2(d).

If the opening the access door, guard, or grille is necessary for intended operation, except for replacement or cleaning of the wick, the latching means shall not require the use of tools. A friction-type clip alone is not acceptable.

*Exception: A heater constructed so that the burner does not dislodge from its intended position during heater tipover need not comply with this requirement.*

## 6 Protection Of Service Personnel

6.1 An uninsulated high-voltage live part and moving parts that may cause injury to persons shall be located, guarded, or enclosed to reduce the risk of unintentional contact by personnel performing service functions that may have to be performed with the equipment energized.

6.2 Service functions that may have to be performed with the equipment energized include the following:

a) Adjusting the setting of temperature controls with or without marked dial settings,

b) Resetting a control trip mechanism,

c) Operating manual switches, or

d) Adjusting air-flow dampers.

A factory set and sealed control is not considered to be adjustable.

6.3 The requirement in 6.1 is not applicable to mechanical service functions that are not normally performed with the equipment energized. Such functions include cleaning and replacement of strainers and filters.

6.4 An adjustable or resettable electrical control or manual switching device may be located or oriented with respect to uninsulated high-voltage live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the intended direction of access if uninsulated high-voltage live parts or moving parts likely to cause injury to persons are:

a) Not located in front, in the direction of access, of the mechanism, and

b) Not located within 6 inches (152 mm) on any side or behind the mechanism, unless guarded.

6.5 An electrical control component that may require examination, adjustment, servicing, or maintenance while energized, excluding voltage measurement except for jacks or terminals specifically intended for that purpose, shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical service functions without subjecting the serviceman to a risk of electric shock from adjacent uninsulated live parts or to a risk of injury to persons from adjacent moving parts.

6.6 Accessibility and reduction of the risk of electric shock and unintentional contact with moving parts that may cause injury to persons may be obtained by mounting the control components in an assembly so that unimpeded access is provided to each compartment through an access cover or panel in the outer cabinet and the cover of the control assembly enclosure with the following arrangement. (see Figure 6.1):

a) The components are located with respect to the access opening in the outer cabinet so that the farthest component in the control assembly is not more than 14 inches (356 mm) from the plane of the access opening.

b) Uninsulated live parts outside the control assembly projected clear space (except for live parts within a control panel) or unguarded moving parts likely to cause injury are located not closer than 6 inches (152 mm) from any side of the access area. The projected clear space is considered to be bounded on the sides by the projection of the smallest rectangular perimeter surrounding the outside edge of the component or control enclosure when provided. The access area is considered to be bounded on the sides by the projection of the perimeter of the access opening in the outer cabinet to the closest rectangular perimeter surrounding the outside edge of the component or control enclosure.

c) The volume generated by the projected clear space of the control assembly to the access opening in the outer cabinet (within the access area) is completely free of obstructions, including wiring.

d) Access to the components in the control assembly is not impeded in the direction of access by other components or by wiring in this assembly.

e) Extractor-type fuseholders and snap switches mounted through the control assembly enclosure are to be located so that:

1) There is unimpeded access to these components through the access opening in the outer cabinet, and

2) So that they are not immediately adjacent to uninsulated live parts outside the control assembly enclosure, unless guarded. See 6.4.

6.7 Components in a low-voltage circuit shall comply with the requirements of 6.5 in their relation to uninsulated live parts in a high-voltage circuit and to moving parts that may cause injury to persons.

6.8 The following are not considered to be uninsulated live parts:

a) Coils of controllers;

b) Relays and solenoids;

c) Transformer windings, if the coils and windings are provided with insulating overwraps;

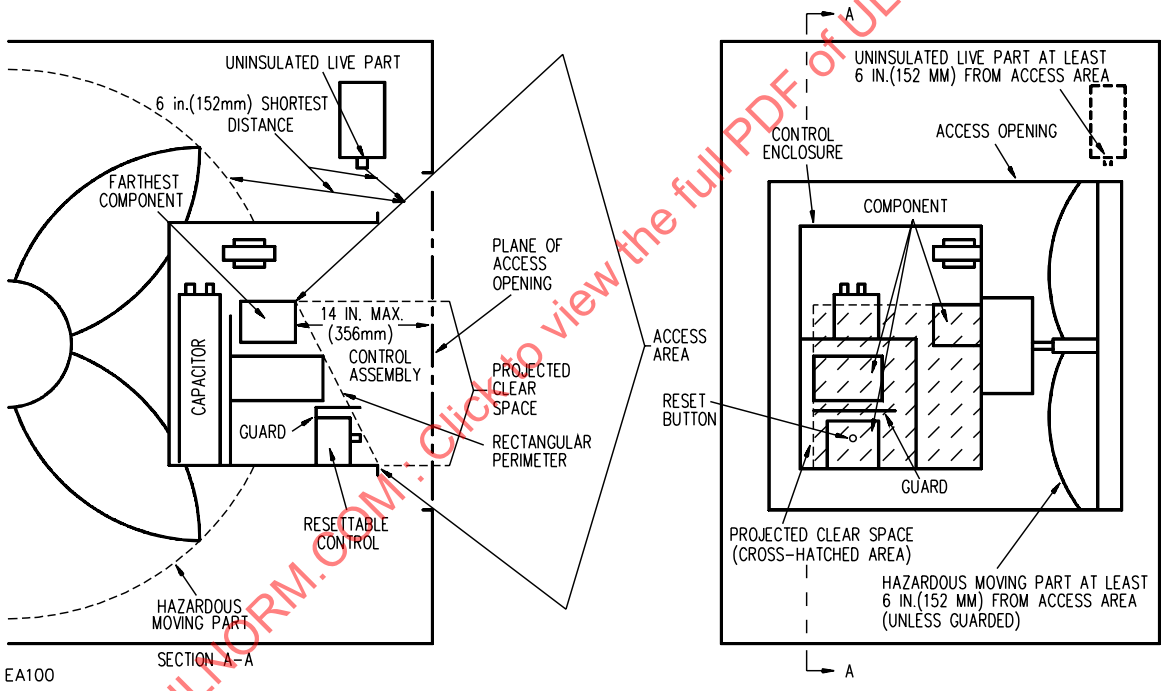
d) Enclosed motor windings;

e) Insulated terminals and splices; and

f) Insulated wire.

**Figure 6.1**
**Accessibility and protection from live parts and moving parts**

Figure 6.1 revised November 2, 1998



6.9 Moving parts that may present a risk of injury to persons, such as fan blades, blower wheels, belts, and the like, shall be guarded or enclosed so that the minor dimension of any opening will not exceed the values indicated in 6.10. A part required for guarding shall be secured by means dependent upon tools for removal unless functioning of the heater requires the part to be in place.

6.10 The distance from an opening to a moving part shall be as specified in Table 6.1, but the minor dimension of the opening shall not in any case exceed 1 inch (25.4 mm). For an opening having a minor dimension intermediate between two of the values included in the table, the distance from the opening to the moving part shall not be less than that found by appropriate interpolation between the corresponding values in the right-hand column of the table. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe than can be inserted through the opening with a force of 5 pounds (22.3 N).

**Table 6.1**
**Distance from opening to moving part**

| Minor dimensions of opening[a] | | Minimum distance from opening to moving part | |
|---|---|---|---|
| Inches | mm | Inches | mm |
| 1/4 | 6.4 | 1/2 | 13 |
| 3/8 | 9.5 | 1-1/2 | 38 |
| 1/2 | 12.7 | 2-1/2 | 64 |
| 3/4 | 19.0 | 4-1/2 | 114 |
| 1 | 25.4 | 6-1/2 | 165 |

[a] Openings less than 1/4 inch (6.4 mm) are not to be considered.

6.11 The requirements in 6.9 and 6.10 do not apply if:

a) a moving part is unlikely to be contacted through the opening because of fixed components, including baffles, or

b) the part is made inoperative when exposed, through the use of an interlocking device.

## 7 Accessibility For Servicing

7.1 A heater shall be constructed to provide access for cleaning of parts, such as interior surfaces of vaporizing burners, wicks, heating surfaces in contact with combustion products, fuel inlet pipes, and fuel strainers, without major dismantling of the heater or removal of parts required to be factory-assembled.

7.2 With respect to 7.1, removal of an access panel, burner, cap, plug, or the like, specifically designed to permit removal or replacement for servicing, is not considered major dismantling.

7.3 Accessibility shall be provided for cleaning, inspection, repair, and replacement of all burners and controls when the heater is installed as intended by the manufacturer. The disposition of parts in the assembly removed for servicing shall be such that their restoration, following removal, will not necessitate their realignment to secure their intended relationship with other parts of the assembly. Tools other than common household tools required for servicing to be performed by the operator shall be provided with the heater.

## 8 Materials

### 8.1 General

8.1.1 A heater shall be constructed of materials having the necessary strength and durability to provide intended service of the parts and the assembly. Parts shall not sag, distort, melt, oxidize, or show leakage of fuel during any of the tests specified herein.

### 8.2 Fuel confining parts

8.2.1 A fuel-confining part of a heater or an operating part, if malfunction of the part would allow leakage of fuel, risk of fire, or prevent a safety device from functioning, shall have the necessary strength, durability, and resistance to fire to provide intended service of the parts and the assembly. Parts formed from drawn- or machined-brass rod or bar stock shall comply with the 10-Day Moist Ammonia Air Stress Cracking Test, Section 61A.

8.2.1 revised April 5, 1994

8.2.2 A fuel tank shall comply with the corrosion protection requirements for Integral and Removable Fuel Tanks, Section 20. All other fuel-confining parts as mentioned in 8.2.1 shall be protected against corrosion by painting, plating, or other equivalent means.

8.2.3 To comply with the requirements in 8.2.1, a material having a melting point (solidus temperature) of not less than 950°F (510°C) and a tensile strength of not less than 10,000 psi (68.9 MPa) at 400°F (204.4°C) is to be used if otherwise acceptable for the service.

8.2.4 A material used for gaskets and seals to confine kerosene shall be compatible with kerosene as determined by tests in accordance with Gasket Tests, Section 64.

### 8.3 Polymeric materials

8.3.1 These requirements apply to polymeric materials used to form outer enclosures, structural or functional parts, thermal and acoustical insulation, and miscellaneous parts of the heater. They do not apply to materials used as electrical insulation, nor to small parts, such as control knobs, buttons, insulating bushings, resilient mounts, clamps, and wiring straps.

8.3.2 The acceptability of polymeric material shall be determined for each application.

8.3.3 Among the factors that are taken into consideration when judging the acceptability of a polymeric material are:

a) Flame resistance,

b) Mechanical strength,

c) Resistance to impact,

d) Moisture absorptive properties, and

e) Resistance to distortion at temperatures to which the materials may be subjected under conditions of normal or abnormal usage.

All of these factors are considered with respect to aging. See Table 8.1 for properties to be evaluated depending on use of the material.

8.3.4 A polymeric material that serves as an electrical enclosure or as a guard to reduce the risk of contact with moving parts that may cause injury to persons shall be evaluated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

8.3.5 A functional part shall not be exposed to temperatures higher than the temperature rating of the material from which it is formed or fabricated, as established in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. The maximum exposure temperature shall be determined in accordance with the Temperature Test, Section 48.

**Table 8.1**
**Evaluation of properties of polymeric materials**

| Characteristics to be evaluated | Enclosures | Structural parts | Thermal and acoustical insulation | Functional parts |
|---|---|---|---|---|
| Flammability | | | | |
| Source of Ignition | | | | |
| External | Yes | Yes | | |
| Internal | Yes | Yes | Yes | Yes |
| Heat Deflection | Yes | Yes | | |
| Water Absorption | Yes | Yes[a] | | |
| Environmental Exposure | Yes | Yes[a] | | |
| Air Oven Aging | Yes | Yes | | |
| Mechanical | | | | |
| Tensile and Flexural Strength | Yes | Yes | | Yes |
| Izod or Tensile Impact Strength | Yes | Yes | | |
| Impact | Yes | Yes | | |
| Volume Resistivity | Yes[a] | Yes[a] | Yes[a] | Yes[a] |

[a] When Applicable

## 8.4 Material designation

8.4.1 Materials are designated with respect to flammability characteristics and are identified as 5V, V-1, or V-2; HF-1 or HF-2; B and HBF materials. See the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

8.4.1 revised November 2, 1998

## 8.5 Ignition sources

8.5.1 As used in 8.6.1 – 8.6.7, possible ignition sources within the product, in addition to the burner flame, are considered to be wiring and any electrical component, such as a switch, relay, transformer, motor winding, and the like, not enclosed in metal or 5V material.

8.5.1 revised November 2, 1998

## 8.6 Material application

8.6.1 A part formed of polymeric material that supports or isolates electrical components, or that is exposed to ignition sources within the product, shall be of 5V material.

8.6.1 revised November 2, 1998

8.6.2 A polymeric material shall have a flammability rating of V-0, V-1, or V-2. Under the following conditions:

a) It does not support or isolate electrical components,

b) It is not exposed to ignition sources within the product, or

c) It is not enclosed in metal as specified in 8.6.7.

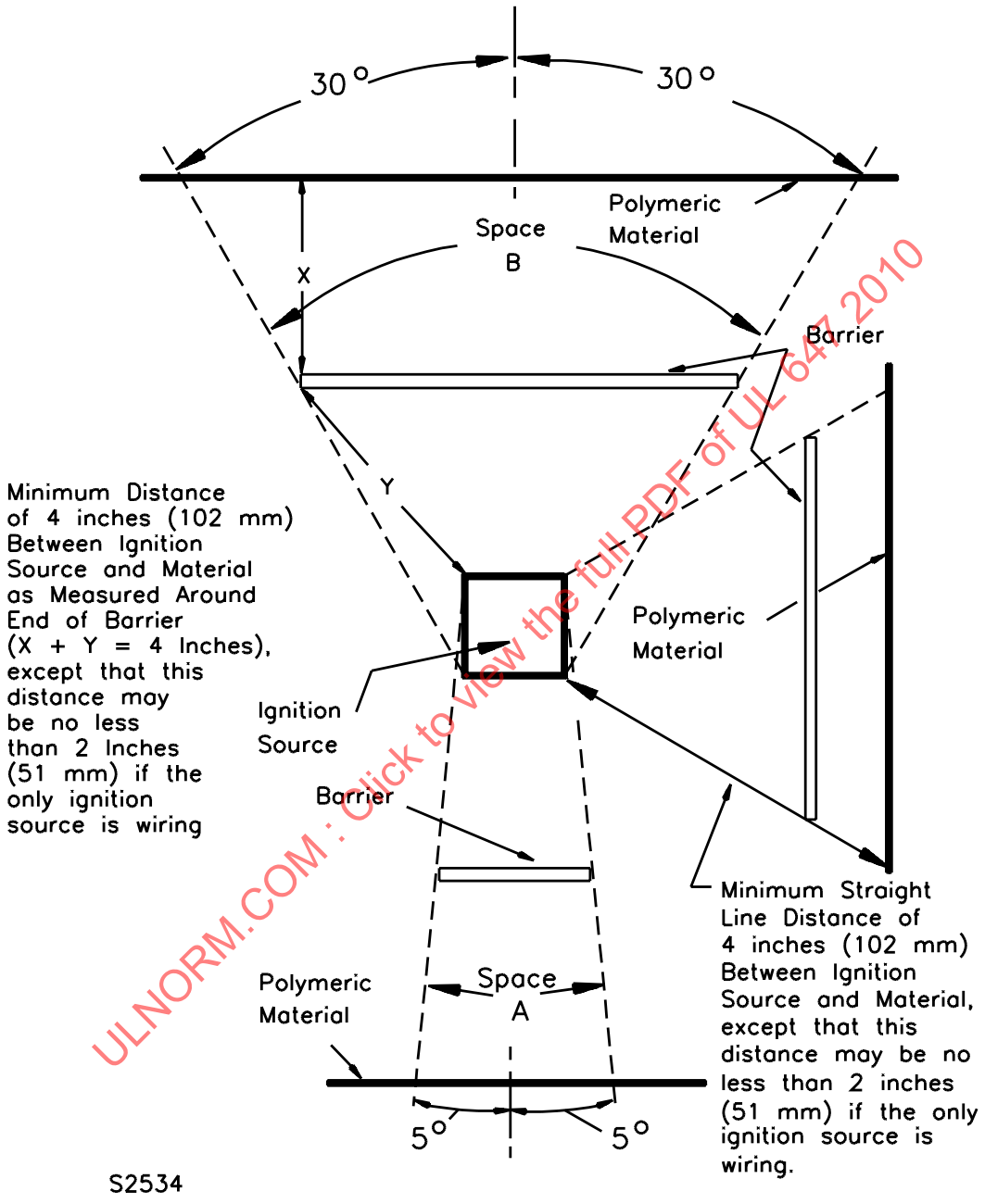
8.6.2 revised November 2, 1998

8.6.3 A V-1 material may be used if it is not exposed to ignition sources. See 8.6.4 and 8.6.5. A V-2 material may be used if, in addition to being isolated from ignition sources in the same manner as a V-1 material, there are no flammable materials or openings or both in the enclosure below the V-2 material within a volume defined by Space A of Figure 8.1.

8.6.3 revised November 2, 1998

**Figure 8.1**
**Exposure to ignition source**

Figure 8.1 revised November 2, 1998






Space A – Represents the volume below the ignition source determined by a straight line that moves about the ignition source while remaining at an angle of 5° from the vertical and is always so oriented that the volume is a maximum.

Space B – Represents the volume above the ignition source determined in the same manner as Space A, except that the angle is 30° from the vertical.

8.6.4 A material located below the ignition source and within Space A of Figure 8.1 may be isolated by means of a horizontal barrier extending at least to the boundary surface of the space. A material located above the ignition source and within Space B of Figure 8.1 may be isolated by means of a barrier, extending at least to the boundary surface of the space, and so located that the minimum distance between the material and ignition source is 2 inches (50.8 mm) for wiring and 4 inches (102 mm) for electrical components.

8.6.5 A material located essentially in the vertical plane and adjacent to an ignition source is considered isolated from the ignition source if it is separated from wiring by a distance of 2 inches (50.8 mm) and from electrical components by a distance of 4 inches (102 mm). A barrier may be used for isolation provided the size of the barrier is such that the minimum straight-line distance between the material and ignition source is 2 inches for wiring and 4 inches for electrical components. See Figure 8.1.

8.6.6 A barrier used to isolate materials as described by 8.6.4 or 8.6.5 shall be formed of metal or of a 5V material and shall be mechanically secured in place.

8.6.6 revised November 2, 1998

8.6.7 The requirements in 8.6.2 – 8.6.5 do not apply to:

a) A polymeric material completely enclosed in metal that is at least 0.010 inch (0.25 mm) thick, or

b) A material classed as HB, V-1, V-2, HB-2, or HBF that is laminated between two metal surfaces if:

1) The thickness of the metal of each surface is 0.010 inch or more, and

2) The exposed vertical surface of the material has a width of not more than 3/8 inch (9.5 mm).

8.6.7 revised November 2, 1998

## 9 Base

9.1 The base of a heater shall be constructed of metal or fabricated of other nonflammable material in a manner that provides equivalent strength and durability.

9.2 A subbase or tray, if furnished as a separate assembly, shall be arranged for attachment to the heater in the intended position only and in a manner that will establish and maintain the intended position of the heater with respect to the subbase or the tray.

## 10 Casing

10.1 The casing or jacket shall be made of steel or material of equivalent strength and durability so that it is not likely to be damaged by handling in shipment, installation, and use.

10.2 The upper drum or casing of a heater shall be provided with a sufficient number of permanent openings so that the heater complies with the Combustion Test, Section 43.

## 11 Radiation Shields

11.1 A radiation shield or liner shall be constructed, formed, and supported so that it can be positioned as intended and so that it cannot distort or sag in service. A shield or liner shall be protected against corrosion if its deterioration may cause:

a) Temperatures higher than specified in Table 48.1 when the heater is tested in accordance with this standard, or

No Text on This Page

b) Improper combustion as determined by the Combustion Test, Section 43.

Any finish to obtain the required resistance to corrosion shall not be damaged by heat when the heater is subjected to the performance tests.

11.2 A radiation shield or baffle employed to prevent temperatures in excess of those specified in Table 48.1 shall be:

a) Assembled as part of the heater, or

b) Constructed so that the heater cannot be assembled for operation without first attaching the required shield or baffle in its intended position.

## 12 Primary Safety Control

12.1 A heater shall be equipped with means to limit discharge of fuel at the burner in case of no ignition or premature flame extinguishment.

12.2 A heater equipped with a vaporizing burner may be provided with a constant-level valve incorporating an automatic shutoff device or with a barometric tank and sump assembly arranged to maintain a level of oil complying with 47.1.

12.3 The primary input to a safety-control circuit shall be a 2-wire, 1-side grounded system, having a voltage rating of a nominal 120 volts. A switch or protective device shall be in the circuit electrically connected to the ungrounded supply conductor.

## 13 External Manual Shutoff Devices

13.1 A heater shall be equipped with an external manual-shutoff device to extinguish the burner flame. The device shall be operable by a motion in one direction, such as pushing a button or lever. Rotation of a knob is not considered to comply with this requirement. The shutoff device may actuate the mechanism intended to extinguish the burner flame in the event the heater is tipped over (see 5.10).

*Exception: On a heater equipped with a vaporizing burner, the manual shutoff device may be located behind a hinged door.*

13.2 The external manual-shutoff device shall be marked as specified in 71.7.

13.2 revised January 26, 2000

## 14 Burners

14.1 A burner shall be of the wick, lighting ring, wickless, or equivalent type that inherently or by use of a primary safety control will limit the discharge of fuel.

14.2 The wick of a wick-type burner shall be provided with means to maintain its shape, to facilitate even travel, and for adjustment.

14.3 A wick-type burner shall be provided with a wick stop to control the wick travel between the maximum and minimum limits. The wick stop at the minimum limit shall be self-latching. The self-latching means shall consist of either of the following or the equivalent:

a) A construction requiring at least two different simultaneous or sequenced actions to override the minimum stop (see 14.4), or

b) A mechanical stop that will not permit operating of the heater below the minimum recommended burner setting.

Revised 14.3(a) effective August 19, 1994

14.4 A heater that incorporates a minimum wick stop that can be overridden in accordance with 14.3(a) shall be marked with a warning statement to not operate the heater at lower than the minimum wick stop setting. See 72.2.

Added 14.4 effective August 19, 1994

14.5 A burner shall be secured so that it will not twist, slide, or drop out of position.

*Exception: A wick type burner that seats in a well and is engaged by a flange to retain the burner in its intended position need not be further secured, provided it is marked with a cautionary statement instructing that it be properly seated each time the heater is used. See 72.3.*

Added exception to 14.5 effective August 19, 1994

## 15 Fittings And Piping

15.1 Pipe and fittings shall be standard full-weight wrought iron or steel, or iron-pipe size brass or copper pipe. Unions, if used, shall be the ground-joint type or the equivalent.

15.2 Tubing incorporated in the assembly of the heater at the factory shall be arranged to reduce the likelihood of being mechanically damaged, such as by closely following the contour of the assembly. Seamless drawn aluminum or copper tubing employed in the fabrication of factory-assembled equipment shall have the wall thickness specified in Table 15.1.

**Table 15.1**
**Aluminum and copper tubing**

| Outside diameter, | | Wall thickness, | | Wall tolerance, plus or minus | |
|---|---|---|---|---|---|
| Inches | (mm) | Inches | (mm) | Inches | (mm) |
| 1/4 | (6.35) | 0.030 | (0.76) | 0.0035 | (0.89) |
| 5/16 | (7.94) | 0.030 | (0.76) | 0.0035 | (0.89) |
| 3/8 | (9.53) | 0.030 | (0.76) | 0.0035 | (0.89) |
| 1/2 | (12.70) | 0.035 | (0.89) | 0.0035 | (0.89) |
| 5/8 | (15.88) | 0.040 | (1.02) | 0.0035 | (0.89) |
| 3/4 | (19.05) | 0.042 | (1.07) | 0.0035 | (0.89) |

15.3 Steel tubing of the seamless, brazed, or welded type employed in the fabrication of factory-assembled equipment shall have a wall thickness of not less than that specified in Table 15.2.

**Table 15.2**
**Steel tubing**

| Outside diameter, | | Minimum wall thickness, | |
|---|---|---|---|
| Inches | (mm) | Inches | (mm) |
| 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 | (12.70) | 0.028 | (0.71) |
| 5/8 | (15.88) | 0.035 | (0.89) |
| 3/4 | (19.05) | 0.035 | (0.89) |

15.4 Steel tubing used for confinement of kerosene shall be composed of corrosion-resistant material, such as stainless steel, or shall be plated, dipped, coated or otherwise treated to resist external corrosion.

15.5 Flexible metal hose, if used, shall be of a type acceptable for the purpose and be used in a manner that it is not likely to be damaged.

15.6 All pipe ends and openings in fittings for pipe connections shall be threaded in accordance with American Standard for Taper Pipe Threads, unless other acceptable forms of construction are provided.

15.7 Care shall be observed to remove webs, shoulders, and other obstructions from the inner ends of internally threaded openings in fittings to permit making tight joints.

15.8 Fuel line shall terminate in a manner that will permit ready connection to the heater.

15.9 Piping and tubing for fuel lines shall be of size and arrangement to avoid air traps.

15.10 An opening into fuel-handling parts shall be covered or encased to prevent entrance of foreign material prior to installation.

## 16 Catalysts

16.1 A catalyst, if used to eliminate odors caused by heater operation, shall be cleanable, nontoxic, and be used within the temperature rating of the materials.

16.2 A heater equipped with a catalyst shall comply with the Combustion Test, Section 43, when the catalyst is removed from the heater.

16.3 A catalyst shall be field replaceable by use of ordinary tools, such as a screwdriver, pliers, wrench, and the like.

16.4 A catalyst shall be arranged in the heater so that the burner flames will not impinge on the catalyst.

## 17 Strainers

17.1 A small orifice or other opening in fuel-supply systems likely to become clogged shall be protected by strainers.

17.2 Individual screening openings of the straining element of a primary strainer shall not be larger than those of a 50-mesh screen.

17.3 The primary strainer element shall provide at least 1/2 square inch (161.3-$mm^2$) effective area of screen opening per gallon (3.8 L) of fuel consumed per hour by the burner, but not less than 1 square inch (645.2-$mm^2$) total.

17.4 A metal screen more than 60 mesh shall be made of monel or the equivalent, and one of 60 mesh or less shall be made of brass or the equivalent.

17.5 A secondary strainer (one supplementary to the primary strainer) smaller in area than required by 17.3 may be used in the fuel line if its openings are considered as orifices and, when used, shall be protected by strainers of finer mesh.

17.6 A primary strainer shall be located to permit the ready removal of the screen without breaking the fuel line or disturbing any part of the heater assembly. The force necessary to open the strainer shall not permanently distort the assembly as installed on the heater.

17.7 A float valve, metering valve, and automatic regulating and shutoff valve shall be protected by a strainer of not less than 50 mesh.

## 18 Stuffing Boxes

18.1 If packing is used to prevent leakage of kerosene around a shaft or stem, a stuffing box complying with the requirements in 18.2 – 18.7 shall be used if the construction is such that it is necessary for the user to adjust or renew the packing to prevent leakage during intended usage or as wear occurs.

18.2 A stem or part shall have sufficient strength so that it cannot be twisted off or distorted by intended operation. A stem or part made of metal subject to corrosion shall engage or seat onto corrosion-resistant material only.

18.3 A stuffing box shall be provided with a removable, shouldered, unthreaded follower gland and with a nut, take-up, or other means for adjusting the gland to maintain pressure on the packing as wear occurs.

18.4 A stuffing box gland shall be made of corrosion-resistant material. The assembly of parts shall be such as to result in compressing the packing against the stem when the stuffing-box nut or yoke is tightened.

18.5 Before shipment, a stuffing box shall be fully packed with pliable packing material, the impregnation of which is not impaired by contact with kerosene.

18.6 The construction shall permit repacking the stuffing box without requiring the assembly to be dismantled.

18.7 A manually operated stem shall not back out, nor shall threads of a stem enter a stuffing-box recess, when the stem is rotated or reciprocated in any allowable manner even though an adjustable packing nut or other take-up is disengaged.

## 19 Sumps

19.1 A sump of a heater employing barometric feed shall be made of nonflammable material. The material used shall be of sufficient thickness and be so formed as to provide strength, rigidity, and durability equivalent to:

a) Uncoated sheet steel not less than 0.042 inch (1.07 mm) thick, or

b) Coated sheet steel shall comply with 20.7 – 20.9.

19.2 A sump shall be secured in position and mounted so that the weight of the sump and fuel supply is not to be supported by the fuel piping. See 5.6 and 58.1.

19.3 A joint below the liquid level in a sheet-metal sump shall be mechanically secured and soldered, or of an equivalent construction. See 20.14.

## 20 Integral and Removable Fuel Tanks

20.1 A fuel tank for a portable heater shall have a capacity of not more than 2 gallons nominal, 2.1 gallons (7.95 L) maximum. See Tank-Capacity, Section 41.

20.2 A vacuum or gravity tank or tanks for a heater shall have a capacity of not more than 2 gallons nominal, 2.1 gallons (7.95 L) maximum. A heater shall not be provided with more than two tanks having an aggregate capacity in excess of 2 gallons nominal, 2.1 gallons maximum.

20.3 A fuel tank shall be constructed of material acceptable for the purpose. Materials other than those specified in 20.5 – 20.12 and 20.14 shall be investigated to determine their acceptability for the purpose.

20.4 Except as specified in 20.3, the thickness of sheet metal employed in a fuel tank shall not be less than specified in 20.5, 20.6, or 20.12.

20.5 The thickness of uncoated sheet steel shall not be less than 0.042 inch (1.07 mm). A preservative shall be applied to uncoated surfaces to prevent rusting prior to use.

20.6 The wall thickness of aluminum-coated steel, galvanized steel, terne sheet, and corrosion-resistant sheet metal shall be not less than 0.016 inch (0.41 mm) uncoated. Coated sheet shall be of prime finish, that is, free from blisters, flux, and uncoated spots visible to the unaided eye.

20.7 Zinc coating on sheet steel shall not be less than Grade G90. Galvanized steel conforming

a) The Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality, ASTM A526-85, or

b) The Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality, ASTM A527-85,

certified as such by the steel mill, as evidenced by a marking on each bundle or roll, ordinarily conforms to the above.

20.8 The coating of terne sheet shall not be less than 8 – 12 pounds (3.6 – 5.4 kg) per double base box [112 sheets, 20 by 28 inches (508 by 711 mm)].

20.9 The coating of aluminum-coated steel sheet shall not be less than 0.5 ounce per square foot (152.8 g/m$^2$) of sheet.

20.10 A material with coatings other than as described in 20.7 – 20.9 may be investigated for equivalency to Grade G90 zinc-coated steel not less than 0.019 inch (0.48 mm) thick.

20.11 A material having each side differently coated may be used, provided the material complies with 20.10 on the side of the material that is in contact with kerosene. The outside of the fuel tank shall be provided with corrosion protection by painting or plating.

20.12 A vacuum or a gravity tank made of uncoated sheet steel, aluminum-coated steel, galvanized steel, and terne sheet shall be of the full-drain construction.

20.13 With respect to 20.12 full drain construction is obtained by constructing a tank so that it is emptied through the fuel outlet at the bottom of the tank.

20.14 A joint of a fuel tank shall be locked-seamed, brazed, welded, or otherwise made mechanically secure. A joint not continuously brazed or welded shall be thoroughly sweated with solder or the equivalent. Brazing or welding of coated sheets less than 0.042 inch (1.07 mm) thick shall not damage the coating of surfaces in contact with kerosene when the tank is full. All connections shall be made through solid threaded bosses or fittings mechanically secured to the tank.

20.15 A gravity fuel tank shall be constructed for integral attachment to the heater. A vacuum fuel system shall employ a removable tank. In either case, the tank shall be supported securely in the intended position on the heater so that it complies with the Tank Securement Test, Section 45. A vacuum fuel tank shall automatically seal the fuel opening when the tank is lifted from the sump or replaced into the sump.

20.16 An integral, gravity fuel tank shall be provided with a liquid-level indicator readily observable while the tank is being filled, unless the fill opening is of a shape and size permitting ready observation of the fuel level within the upper 2 inches (50.8 mm) below the lowest point of overflow while the tank is being filled.

20.17 A vacuum fuel tank shall be equipped with a fuel-level gauge.

20.18 A tank that employs a gauge glass or any other fuel-level indicator that, when damaged, may allow flooding at the burner or escape of fuel from the tank either when the tank is installed on the heater as intended, or is in a position in which it may be stored or carried, shall be tested in accordance with the Vacuum-Tank Fuel-Indicator-Impact and -Drop Tests, Section 65. If the indicator employs thermoplastic, gasket, or other seal materials, the tanks shall also be subjected to the Gasket Tests, Section 64.

20.19 A tank as described in 20.18 shall be marked as specified in 71.1.

20.20 The top of the fill opening of a tank not equipped with a gauge complying with the requirement in 20.16 shall not be above the level at which fuel will overflow the tank.

20.21 A tank for a portable heater shall be provided with a fill cap that effectively closes the fill opening in accordance with 54.8 and 54.9. The fill cap shall be attached to the heater by a chain or equivalent means.

20.22 A gravity tank shall permit ready filling by the user without the user's having to reach over the heater and in a manner that will reduce the likelihood of spillage of fuel.

## 21 Guards and Grilles

21.1 Except as specified in 21.2, a heater surface that attains a temperature higher than 50°C (90°F) above ambient shall be protected by a guard or grille to reduce the risk of unintentional contact with the surface. To determine the surface temperatures, the heater is to be tested as described in 49.2(a),(b) or (c), as appropriate for the type of heater. A heater provided with a guard or grille as specified in 21.2 – 21.10 is acceptable. The applicable requirements for a guard or grille are determined in accordance with Figure 21.1. The path on the flow chart that matches the heater construction is to be selected.

21.2 The following surfaces and parts of the heater need not comply with 21.1:

a) A guard or grille that complies with the requirements in 21.3, 21.6, or 21.7.

b) A burner extension, such as a small handle for manipulation of the burner during lighting, provided:

1) The operating instructions furnished with the heater do not require manipulation of the burner extension during heater operation, and

2) The burner extension is recessed a minimum of 1/2 inch (12.7 mm) behind the opening in the guard or grille. The opening for manipulation of the burner extension shall not be higher than 1-1/2 inches (38.1 mm) for a width of 3 inches (76.2 mm) unless larger openings are acceptable in accordance with Table 21.1, 21.2, or 21.3, as applicable for the construction of the guard or grille.

c) A burner access door having a surface area less than 100 $cm^2$, if the door (excluding handle) is recessed a minimum of 1/2 inch behind an opening in a guard or grille.

d) Portions of a heater that function as a reflector, incidental surfaces such as edges of a reflector, members of a guard or grille greater than 3.6 mm in diameter, and the like, that

1) Are recessed a minimum of 1/2 inch from the external surface of a guard or grille that complies with the requirements in 21.3, 21.6, or 21.7, or

2) Cannot be contacted by a 3/4-inch (19.1-mm) diameter hemispherically tipped probe.

e) Guard or grille supports formed of wire greater than 3.6 mm diameter that attach the guard or grille to the heater, and that are essentially perpendicular to and located behind the external surface of a guard or grille that complies with the requirements in 21.3, 21.6, or 21.7.

f) A handle, knob, button, or the like, and adjacent surfaces shall comply with the temperature limits specified in note g to Table 48.1.

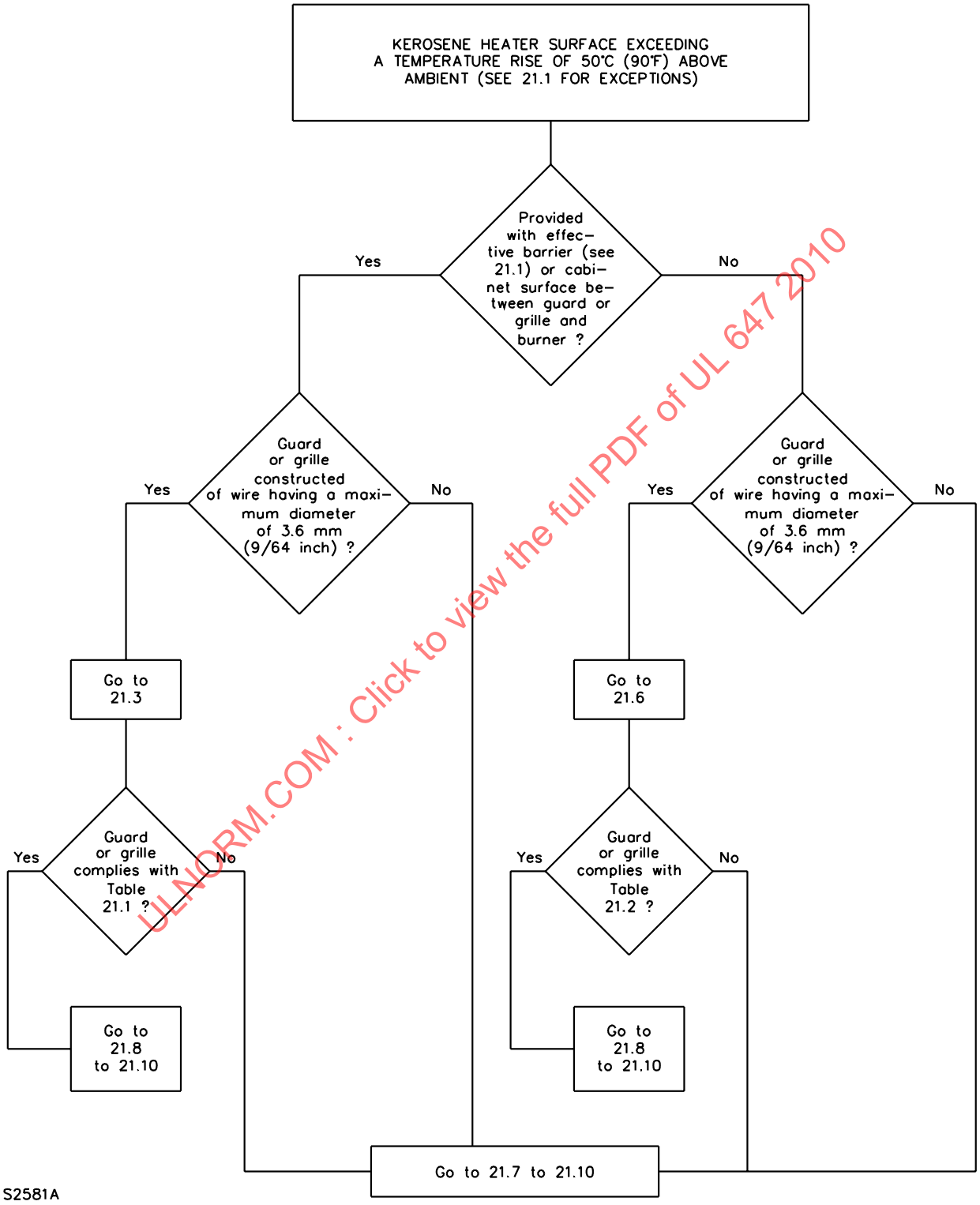
g) A bail handle and its integral parts that comply with the requirements in 5.8.

h) A forced air outlet opening in an essentially vertical surface provided:

1) The heater cannot be operated without the fan in operation, and

2) The average outlet air temperature does not exceed 121°C (250°F). See 39.2.9.

**Figure 21.1**
**Determination of applicable guard and grille requirements**



## Table 21.1
## Spacings for guard or grille from hot surface

| Barrier or cabinet surface temperature rise | Minimum spacing from outer surface of guard or grille to hot surface of barrier or heater cabinet, inches (mm) | Maximum minor dimension of opening in guard or grille inches (mm) |
|---|---|---|
| Greater than 50 to 96°C (90 to 173°F) | 1 (25.4) | 1 (25.4) |
| Greater than 96 to 152°C (173 to 274°F) | 2 (50.8) | 2 (50.8) |
| Greater than 152°C (274°F) | 3 (76.2) | 3 (76.2) |

## Table 21.2
## Spacings for guard or grille from burner

| Minor Dimensions of opening in guard or grille[a] inches (mm) | Minimum acceptable spacing from outer surface of guard or grille to burner, inches (mm) |
|---|---|
| 1 (25.4) or less | 2-1/2 (63.5) on sides<br>3 (76.2) on top |
| 2 (50.8) | 4-1/2 (114.0) |
| 3 (76.2) | 6-1/2 (165.0) |

[a] For an opening having a minor dimension intermediate between two of the values specified in the table, the spacing to the burner shall not be less than that determined by interpolation between the corresponding values in the right-hand column of the table.

**Table 21.3**
**Guard or grille minor opening dimension**

| Spacing from outer surface of guard or grille to burner or hot surface[a] | | Minor dimension of opening in guard or grille | |
|---|---|---|---|
| Inches | (mm) | Inches | (mm) |
| 1/2 | (12.7) | 1/2 | (12.7) |
| 1-1/2 | (38.1) | 3/4 | (19.1) |
| 2-1/2 | (63.5) | 1 | (25.4) |
| 4-1/2 | (114.0) | 2 | (50.8) |
| 6-1/2 or greater | (165.0) or greater | 3 | (76.2) |

[a] A distance less than 1/2 inch is not acceptable. For a guard or grille having a spacing to the burner or hot surface intermediate between two of the values specified in the table, the minor dimension of the opening shall not be less than that determined by interpolation between the corresponding values in the right hand column of the table.

21.3 A kerosene heater or section of a kerosene heater that is provided with a guard or grille constructed from wire with a maximum diameter of 3.6 mm and that has an effective barrier (see 21.4) or a cabinet surface between the burner and the guard or grille shall comply with the requirements in Table 21.1 or 21.7. The guard or grille shall be located to provide the minimum clearances from the outer surface of the guard or grille to the hot surface of the heater barrier or cabinet based on the barrier or cabinet temperature rise specified in Table 21.1. In addition, the minor dimension of the opening between the guard or grille members shall not exceed the applicable dimension specified in Table 21.1.

21.4 With reference to 21.3 and Figure 21.1, an effective barrier is one that is:

a) Constructed of heat and corrosion-resistant material, such as metal, glass, porcelain, or the like;

b) Mechanically attached to the heater cabinet; and

c) Located to prevent straight-line access to any portion of the burner or burner flame, except through any opening or openings that may be provided for products of combustion and ventilation. Such an opening or openings shall not permit passage of a 1/2-inch (12.7 -mm) diameter probe. For an opening that has a major dimension exceeding 1/4 inch (6.4 mm), the straight-line distance from the outer surface of the guard or grille through the opening to any part of the burner or burner flame shall not be less than 2-1/2 inches (63.5 mm) on the sides of the heater and not less than 3 inches (76.2 mm) on the top of the heater. Metal screen or wire mesh may be used only on the sides of the heater provided the openings in the screen or wire mesh do not exceed 1/4 inch.

21.5 The barrier shall have strength to resist damage to the extent that it would no longer serve as an effective barrier in accordance with 21.4 when the heater is subjected to the first tipover test with a full tank in any direction in accordance with 54.4.

21.6 A kerosene heater or section of a kerosene heater that is provided with a guard or grille constructed from wire a maximum diameter of 3.6 mm and that does not have an effective barrier (see 21.4) or a cabinet surface between the burner and the guard or grille shall comply with the requirements in Table 21.2 or 21.7. The guard or grille shall be located to provide the minimum clearances from the outer surface of the guard or grille to the burner based on the minor dimension of the opening specified in Table 21.2.

21.7 The temperature rise on a guard or grille constructed of wire having a diameter of 3.6 mm or less that does not comply with the requirements in 21.3 and Table 21.1 or in 21.6 and Table 21.2, as applicable, shall not exceed 65°C (117°F) above ambient. The temperature rise on a guard or grille constructed of wire having a diameter of more than 3.6 mm shall not exceed 50°C (90°F) above ambient. Three samples of the heater are to be tested in accordance with 49.2 to determine that these temperature rises are not exceeded. In addition, the minor dimension of the opening between the guard or grille members shall not exceed the applicable dimension specified in Table 21.3 for the distance of the guard or grille to the burner or hot surface.

21.8 Thermocouples used to measure the temperature of a guard or grille are to be secured to the outside surface of the guard or grille by brazing, soldering, or welding. Thermocouples used to measure the temperature of other surfaces are to be secured by brazing, soldering, welding, epoxy cement, tape, or equivalent means that maintain thermal contact with the surface.

21.9 The guard or grille referenced in 21.3, 21.6, and 21.7 shall be positively secured to the heater such as by:

a) Screws, rivets, or welding, or

b) Being engaged in slots so that the guard or grille cannot be removed without the use of a tool or by permanent bending and distortion of the guard or grille. A guard or grille that is not factory-attached is acceptable provided:

1) The guard or grille is shipped in the same carton as the heater.

2) All guard or grille mounting brackets are factory-mounted on the heater and all necessary hardware is provided in the same shipping carton as the heater.

3) The guard or grille can be assembled with simple tools (for example, screwdriver, pliers, and the like).

4) The guard or grille assembly affords simple assembly with a few separate pieces as practicable. [To facilitate field assembly, three pieces (excluding attaching hardware) or less are recommended.]

5) A guard or grille that is partially attached to the heater and is folded or telescoped is capable of being locked into its final intended position, and the heater is marked in accordance with 72.8 unless the heater is provided with an interlock that would prevent heater operation if the guard or grille is not locked in its final intended position.

6) A heater that does not have factory-attached guards or grilles is provided with a marking complying with 72.6 unless the heater is provided with an interlock that would prevent heater operation if all pieces comprising the guard or grille are not attached to the heater in their final intended position.

7) Installation instructions for the guard or grille, as required by 3.2(a), are provided.

*Exception: A guard or grille that is intended to provide access to controls, adjustments, fuel tanks, or other mechanisms that may need to be periodically manipulated may be secured by hinging or in an equivalent manner on one side if the opposite side has a catch mechanism that will retain the guard or grille in a closed position when access is not required. A guard or grille providing direct access to a burner may be provided with a hinge that permits hand removal of the guard or grille while in the unlatched position.*

21.10 A guard or grille as described in 21.3, 21.6, and 21.7 shall not interfere with the carrying handle.

## 22 Valves

22.1 A fuel-regulating device, when adjusted to its maximum allowable setting, shall not permit a burning rate in excess of that determined by test in accordance with these requirements as not presenting a risk of fire.

22.2 The means, if used, for limiting the maximum setting of a regulating device shall not be accessible to the outside and shall be sealed with hard solder or the equivalent, or shall be of a type requiring other than common household tools to increase the flow beyond the intended maximum.

22.3 A fuel-metering valve shall not require more than one and one-half turns to open it fully.

22.4 A valve controlling the supply of fuel to a burner shall be of the needle type or the equivalent. It shall maintain a constant flow of fuel when opened, and operation shall not enlarge the orifice to the extent that would increase fuel flow.

22.5 A plug or rotating-disc type valve, employing the bearing surface of the plug or disc as the liquid seal to the exterior of the valve body, shall not be used in kerosene lines.

22.6 A plug or rotating-disc type valve used in a fuel supply line as a shutoff device shall be provided with a handle assembly clearly designating the shutoff position of the valve.

22.7 A petcock or valve shall not be used that, when open, permits the discharge of kerosene into the room.

## 23 Cord-Connected Units

23.1 A heater intended for cord connection to the power supply shall be provided with a flexible cord and attachment plug of the grounding type, and of the type, voltage rating, ampacity, and current rating consistent with the rating and intended application of the heater.

23.2 The marked current rating of a cord-connected heater shall not exceed the current rating of the attachment plug.

23.3 A cord-connected heater shall employ a grounding-type attachment plug that complies with the ANSI/NEMA designations in Table 23.1.

**Table 23.1**
**Attachment plugs**

| Attachment-plug rating, amperes, volts | ANSI/NEMA designation[a] |
|---|---|
| 15, 125 | 5-15P |
| 20, 125 | 5-20P |
| 15, 250 | 6-15P |
| 20, 250 | 6-20P |

[a] As part of the Standard for Wiring Devices – Dimensional Requirements, ANSI/NEMA WD6-1988.

23.4 A cord-connected heater shall employ Type SJ, SJO, SJT, or SJTO power-supply cord rated for use at a voltage not less than the rated voltage of the heater. The ampacity of the cord as specified in the National Electrical Code, ANSI/NFPA 70-1999, shall not be less than that required by the heater.

23.4 revised January 26, 2000

23.5 The length of a power supply cord shall not be less than 6 feet (1.82 m) and not more than 7 feet (2.13 m). The length is to be measured between the point at which the cord exists the heater and the attachment plug.

23.6 The power-supply cord shall be provided with a strain-relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. If a metallic cord grip is provided, it shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts if it can be moved inward. See Strain-Relief Test, Section 60.

23.7 The edges of the entry hole for th epower-supply cord, including the cord entry hole in a bushing, shall be smooth and rounded, and without burrs, fins or sharp edges that may damage the cord insulation. The power-supply cord shall be routed to prevent damage to the cord insulation.

## 24 Grounding

24.1 The grounding conductor of a cord-connected heater shall be connected to the heater so as to ground all exposed dead metal parts that are likely to become energized.

24.2 A soldering lug, 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 or for the grounding wire in a supply cord.

24.3 On a cord-connected heater, the grounding conductor of the flexible cord shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the heater by a positive means, see Bonding for Grounding, Section 27, that is not likely to be removed during any servicing operation not involving the power-supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

24.4 The continuity of the grounding system of the heater shall not rely on the dimensional integrity of nonmetallic material.

## 25 Internal Wiring

### 25.1 General

25.1.1 The wiring of high- and low-voltage safety-control circuits shall comply with the requirements in this section.

25.1.2 Wiring shall be done with insulated conductors having the current-carrying capacity, voltage, and temperature ratings consistent with their use. A conductor other than an integral part of a component shall not be smaller than 18 AWG (0.82 $mm^2$).

25.1.2 revised April 16, 2010

25.1.3 The wiring for all circuits shall be furnished by the manufacturer as part of the heater. If the heater is not assembled and wired at the factory, such wiring shall be furnished as a harness with each heater and be arranged to facilitate attachment when the heater is assembled; in which case a pictorial diagram showing the exact arrangement of the wiring shall be included with each heater.

25.1.4 If insulated conductors rated for use at temperatures in excess of 140°F (60°C) are required, such wiring shall be furnished as part of the assembly. The devices to be connected by such wiring shall be factory-located on the equipment.

### 25.2 Methods

25.2.1 Electrical wiring to a part that must be moved for maintenance and servicing shall be arranged so that the part may be moved without breaking soldered connections or disconnecting conduit. Conductors to be disconnected from terminals of such a part shall terminate in eyelets or conductors. If the wiring to a part that functions also as an access plate or cover, such as a transformer closing the access to the nozzle assembly, is not readily detachable, then the assembly shall include provision for support of that part by means other than the wiring when the part is moved for servicing. Any allowable movement of such part shall not stress the wiring.

25.2.2 Conductors shall be enclosed within conduit, electrical metallic tubing, metal raceway, electrical enclosure, or metal-clad cable, except as indicated by 25.2.13 and 25.2.14.

25.2.3 Group A of Table 25.1 includes some wiring materials acceptable for use if enclosed as specified in 25.2.2.

25.2.3 revised January 26, 2000

25.2.4 Flexible metal conduit shall not be smaller than nominal 3/8-inch electrical trade size. This does not apply to parts of components, such as conduit protecting flame sensor leads.

25.2.5 Flexible metal conduit shall be mechanically secured at intervals not exceeding 4-1/2 feet (1.4 m) and within 12 inches (0.3 m) on each side of every junction box except for lengths not over 36 inches (0.9 m) where flexibility is necessary.

25.2.6 All splices and connections shall be mechanically secure and bonded electrically. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in the risk of fire or electric shock.

25.2.7 A splice shall be provided with insulation equivalent to that required for the wires involved if permanence of spacing between the splice and other metal parts is not inherent in the construction.

25.2.8 A splicing device, such as a fixture-type splicing connector or pressure wire connector, may be employed if it has insulation rated for the voltage to which it is subjected. Thermoplastic tape wrapped over a sharp edge is not acceptable.

**Table 25.1**
**Typical wiring materials**

Table 25.1 revised April 16, 2010

| Group | Type of wire, cord, cable, or appliance wiring material with insulation thickness at the right corresponding to wire sizes indicated | Wire size | | Insulation thickness | |
|---|---|---|---|---|---|
| | | AWG | $mm^2$ | Inch | mm |
| A | FFH-2, MTW, PF, PFF, PGF, PGFF, RFH-2, RFHH-2, RFHH-3, RH, RHH, RHW, RUH, RUW, SF-2, SFF-2, TF, TFF, TFN, TFFN, THW, THW-MTW, THWN, TW, XHHW, or thermoplastic appliance wiring material. | 10 and smaller | 5.3 | 2/64 | 0.8 |
| | | 8 | 8.4 | 3/64 | 1.2 |
| | | 6 | 13.3 | 4/64 | 1.6 |
| | | 4 | 21.2 | 4/64 | 1.6 |
| | | 3 | 26.7 | 4/64 | 1.6 |
| | | 2 | 33.6 | 4/64 | 1.6 |
| | | 1 | 42.4 | 5/64 | 2.0 |
| | | 1/0 | 53.5 | 5/64 | 2.0 |
| | | 2/0 | 67.4 | 5/64 | 2.0 |
| | | 3/0 | 85.0 | 5/64 | 2.0 |
| | | 4/0 | 107.2 | 5/64 | 2.0 |
| B | S, SE, SJ, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, ST, STO, STOO, or appliance wiring material with thermoplastic or neoprene insulation. | 18 | 0.82 | 4/64 | 1.6 |
| | | 16 | 1.3 | 4/64 | 1.6 |
| | | 14 | 2.1 | 5/64 | 2.0 |
| | | 12 | 3.3 | 5/64 | 2.0 |
| | | 10 | 5.3 | 5/64 | 2.0 |
| | | 8 | 8.4 | 6/64 | 2.4 |
| | | 6 | 13.3 | 8/64 | 3.2 |

Note: Thermoplastic wiring materials, as referenced in Group A, with insulation thickness of 1/32 inch (0.8 mm) for 16 or 18 AWG and 3/64 inch (1.2 mm) for 14, 12, 10, or 8 AWG are considered equivalent to the wiring material referenced in Group B, when the conductors are covered with 1/32 inch wall thickness thermoplastic insulating tubing of a type acceptable for the purpose from the standpoint of dielectric properties, heat resistance, moisture resistance, and flammability.



25.2.9 A splice shall be located, enclosed, and supported so that it is not subject to damage as the result of flexing, motion, or vibration.

25.2.10 A splice is considered to be adequately enclosed if installed in a junction box, control box, or other enclosed compartment in which high-voltage wiring materials, as specified in Group A of Table 25.1, are employed. Splices in enclosed heater compartments are to be secured to a fixed member in the compartment so that they are not subject to movement or damage during servicing.

25.2.11 At all points where conduit or metal tubing terminates, the conductors shall be protected from abrasion. If metal-clad cable is used, an insulating bushing or its equivalent shall be provided between the conductors and the armor.

25.2.12 A wireway shall be such that the interconnection of sections and fittings will provide a rigid mechanical assembly and provide the required electrical conductivity. The interior of the wireway shall be free from burrs and sharp corners or edges that may cause damage to the insulation on wires.

25.2.13 All wiring shall be supported and routed to reduce the risk of damage from sharp edges or moving parts.

25.2.14 Factory wiring involving a potential of not more than 300 volts between parts attached to the same assembly with a predetermined fixed relationship of one to the other may be done with Type SO or ST cord, if all of the conditions specified in items (a) – (c) are met:

a) It is not practical to do the wiring in accordance with 25.2.2.

b) The cord is not required to be bent, twisted, or otherwise displaced during routine maintenance and service.

c) The length of cord exterior to the heater enclosure is not more than 4 inches (102 mm) and strain relief is provided.

25.2.15 Cords or appliance wiring material as referenced in Group B of Table 25.1 may be employed if the wiring is enclosed by a heater casing complying with items (a) – (d):

a) There are no openings in the bottom, unless a U-shaped channel or trough is located under the wiring and the wires do not project through the plane of the top of the trough or channel.

b) Openings in other than the bottom will not permit entrance of a rod having a diameter of 1/2 inch (12.7 mm) and openings for such items as pipe or conduit are not more than 1/2 inch in diameter larger than the object that will be installed through the opening.

c) Openings are not closer than 6 inches (152 mm) to the wiring unless metallic barriers or baffles are placed between the wiring and the openings. Louvered openings of a kind that protect the wiring from mechanical damage from outside the compartment and that are formed to assist in confining an electrical disturbance to within the compartment are exempt from this requirement. The louvers shall be of a drawn metal of a form to completely obscure viewing of the wiring within the compartment when viewed from the horizontal outside the compartment, and the openings shall be located so that an object falling vertically cannot enter the compartment through the louvered opening.

d) Flammable material, other than electrical insulation, located within the casing or compartment is separated from such wiring material, and the material is as specified in 25.2.15. An air filter may be employed within the enclosure.

25.2.16 With reference to 25.2.14(d), plastic materials shall be designed as Type V-0, V-1, V-2, 5V, HF-1, or HF-2 in accordance with the Standard for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. Other nonmetallic materials shall have equivalent characteristics.

25.2.16 revised November 2, 1998

25.2.17 Cords and other wiring material complying with the requirements in 25.2.14 and 25.2.21 shall be arranged to reduce the likelihood of damage, such as by closely following surfaces, and shall be supported. Strain relief, where required, shall be provided.

25.2.18 A hole in a wall or partition through which insulated wires or cords pass and on which they may bear shall be provided with smooth rounded bushings or surfaces to prevent abrasion of the insulation. Bushings, if required, shall be ceramic, phenolic, cold-molded composition, fiber, or equivalent material.

25.2.19 A fiber bushing shall not be less than 3/64 inch (1.2 mm) thick, shall be located so that it will not be exposed to moisture, and shall not be employed where it will be subjected to a temperature higher than 194°F (90°C) under intended operating conditions.

25.2.20 To provide an acceptable unbushed opening in sheet metal usually requires rolling, extrusion, or both of the metal around the opening, or the insertion of a grommet complying with 25.2.17.

25.2.21 Factory wiring of a low-voltage safety circuit may be done with SP-2 cord having all-neoprene insulation, SPT-2 cord or appliance wiring material having neoprene, thermoplastic, or equally durable insulation of equivalent thickness, if such wiring is located in a cavity or compartment of a heater and is shielded.

## 26 Separation of Circuits

26.1 Unless provided with insulation for the highest voltage involved, insulated conductors of different internal wiring circuits shall be separated by barriers or shall be segregated, and shall also be so separated or segregated from uninsulated live parts connected to different circuits or opposite-polarity parts of the same circuit.

26.2 Segregation of insulated conductors may be accomplished by clamping, routing, or equivalent means that provides separation from insulated or uninsulated live parts of a different circuit.

## 27 Bonding for Grounding

27.1 An exposed or accessible dead metal part that may become energized and may be contacted by the user or by service personnel during service operations performed when the heater is energized shall be electrically connected to a point of connection of an equipment ground.

27.2 Except as indicated in 27.3, uninsulated metal parts of cabinets, electrical enclosures, motor frames, and mounting brackets, controller mounting brackets, capacitors and other electrical components, interconnecting tubing and piping valves shall be bonded for grounding if they may be contacted by the user or serviceman.

27.3 Metal parts, as described below, need not be grounded:

a) Adhesive-attached metal-foil markings, screws, handles, or parts that are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts.

b) Isolated metal parts, such as magnet frames and armatures, and small assembly screws that are separated from wiring and uninsulated live parts.

c) A panel or cover that does not enclose uninsulated live parts if insulated parts and wiring are separated from the panel or cover.

d) Panels and covers that are insulated from electrical components and wiring by an attached insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 1/32 inch (0.8 mm) thick.

27.4 A component, such as a switch, likely to become separated from its intended grounding means for purposes of testing or adjustment while the equipment is energized, is to be provided with a grounding conductor not requiring removal for such service.

27.5 A splice shall not be employed in wire conductors used for bonding.

27.6 Metal-to-metal hinge bearing members may be considered as a means for bonding a door for grounding if a multiple bearing-pin type (piano type) hinge is employed.

27.7 A separate bonding conductor shall be of material rated for use as an electrical conductor. Ferrous-metal parts in the grounding path shall be protected against corrosion be enameling, galvanizing, plating, or equivalent means. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage, such as by being located within the confines of the outer enclosure or frame, and

b) Not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor would not ordinarily be omitted after removal and replacement of the fastener.

27.8 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, or by welding, soldering, or brazing with materials having a softening or melting point higher than 850°F (454.4°C). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel.

27.9 A connection that depends upon the clamping action exerted by rubber or similar materials is acceptable if it complies with 27.11 under any degree of compression permitted by a variable clamping device and if the results are still acceptable after exposure to the effects of oil, grease, moisture, and thermal degradation that are likely to occur in service. A clamping device shall be arranged for reassembly in its intended position following disassembly or removal for maintenance purposes.

27.10 If bonding depends on screw threads, two or more screws or two full threads of a single screw shall engage the bonding system to metal.

27.11 If the adequacy of a bonding connection cannot be determined by examination, or if a bonding conductor is smaller than required by 27.12 and 27.13, it shall be acceptable if the connecting means does not open:

a) When carrying for the time specified in Table 27.1 twice the current equal to the rating of the branch-circuit overcurrent device required to protect the equipment, and

b) During a short-circuit test in series with a fuse of the intended rating.

27.12 The size of a conductor or strap employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch-circuit overcurrent device to which the equipment will be connected. Except as specified in 27.11, the size of the conductor or strap shall be in accordance with Table 27.2.

**Table 27.1**
**Duration of current flow, bonding-conductor test**

| Rating of overcurrent protection device, amperes | Minimum duration of current flow, minutes |
|---|---|
| 30 or less | 2 |
| 31 – 80 | 4 |

**Table 27.2**
**Bonding wire conductor size**

| Rating of overcurrent device amperes | Size of bonding conductor[a] | | | |
|---|---|---|---|---|
| | Copper wire | | Aluminum wire | |
| | AWG | ($mm^2$) | AWG | ($mm^2$) |
| 15 | 14 | (2.1) | 12 | (3.3) |
| 20 | 12 | (3.3) | 10 | (5.2) |

[a] Or equivalent cross-sectional area.

27.13 A bonding conductor to a component or electrical enclosure is not required to be larger than the size of the conductors supplying power to the component or components within the enclosure.

ELECTRICAL COMPONENTS

## 28 General

28.1 Electrical equipment and wiring shall be arranged so that during intended use, or when uncoupling of a connection is required for servicing, they will not be contacted by fuel.

## 29 Mounting of Electrical Components

29.1 A switch, fuseholder, lampholder, or similar electrical component shall be mounted to prevent it from turning, except as noted in 29.2 and 29.3.

29.2 The requirement that a switch be prevented from turning away may be waived if all 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 means for mounting the switch is not subject to loosening as the result of operation of the switch.

c) The spacings are not reduced below the required values if the switch rotates.

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

29.3 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 if rotation cannot reduce spacings below the required values.

29.4 The means for preventing turning is to consist of more than friction between surfaces. A toothed lock washer that provides both spring take-up and an interference lock is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

29.5 An uninsulated live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the values specified in High-Voltage Circuits, Section 35, and Low-Voltage Circuits, Section 37.

## 30 Electrical Enclosures

30.1 An uninsulated high-voltage live part shall be enclosed or guarded to reduce the risk of unintentional contact by persons during intended use of the equipment. This applies also to such a part located in a compartment into which access is required for servicing of the equipment, such as resetting controls, replacing filters, lubrication, and cleaning.

30.2 The enclosure shall prevent the emission of molten metal, burning insulation, flaming particles, or the like, through openings onto flammable material, including the surface on which the equipment is mounted.

30.3 A terminal housing of a motor, to which connections are to be made in the field, shall be of metal and shall be sized in accordance with the National Electrical Code, ANSI/NFPA 70-1999.

30.3 revised January 26, 2000

30.4 An enclosure of polymeric materials shall comply with the requirements in 8.3.3 and 8.3.4.

30.5 A steel enclosure shall be protected against corrosion by painting, plating, or other equivalent means.

30.6 Sheet metal complying with Tables 30.1 and 30.2 is acceptable for the individual enclosure of electrical components.

30.7 Where the construction and location of the componnet and the strength and rigidity of the outer cabinet warrant, an individual enclosure of metal thinner than specified in Table 30.1 and 30.2 may be employed.

30.8 If insulating material other than electrical insulation is provided within the enclosure, consideration is given to the burning characteristics and flammability of the material, and the proximity of an ignition source.

30.9 All intended mounting positions of the unit are to be considered when determining if it complies with the requirement in 30.3.

30.10 A junction box that is formed in part by another part, such as a fan scroll or a motor casing shall fit so that:

a) An opening between the box and motor frame having a dimension exceeding 1/2 inch (12.7 mm) does not permit a flat feeler gauge, 5/64 by 1/2 inch (2 by 12.7 mm) wide to enter.

b) An opening between the box and motor frame having no dimension exceeding 1/2 inch does not permit the entrance of a 13/64 inch (5.2 mm) diameter rod.

## Table 30.1
## Minimum thickness of sheet metal for electrical enclosures of carbon steel or stainless steel

| Without supporting frame[a] | | | | With supporting frame or equivalent reinforcing[a] | | | | Minimum thickness, inch (mm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum width[b] | | Maximum length[c] | | Maximum width[b] | | Maximum length | | | | | |
| inches | (cm) | inches | (cm) | inches | (cm) | inches | (cm) | Uncoated | | Metal coated | |
| 4.0 | (10.2) | Not limited | | 6.25 | (15.9) | Not limited | | 0.020 | (0.51) | 0.023 | (0.85) |
| 4.75 | (12.1) | 5.75 | (14.6) | 6.75 | (17.1) | 8.25 | (21.0) | | | | |
| 6.0 | (15.2) | Not limited | | 9.5 | (24.1) | Not limited | | 0.026 | (0.66) | 0.029 | (0.74) |
| 7.0 | (17.8) | 8.75 | (22.2) | 10.0 | (25.4) | 12.5 | (31.8) | | | | |
| 8.0 | (20.3) | Not limited | | 12.0 | (30.5) | Not limited | | 0.032 | (0.81) | 0.034 | (0.86) |
| 9.0 | (22.9) | 11.5 | (29.2) | 13.0 | (33.0) | 16.0 | (40.6) | | | | |
| 12.5 | (31.8) | Not limited | | 19.5 | (49.5) | Not limited | | 0.042 | (1.07) | 0.045 | (1.14) |
| 14.0 | (35.6) | 18.0 | (45.7) | 21.0 | (53.3) | 25.0 | (63.5) | | | | |
| 18.0 | (45.7) | Not limited | | 27.0 | (68.6) | Not limited | | 0.053 | (1.35) | 0.056 | (1.42) |
| 20.0 | (50.8) | 25.0 | (63.5) | 29.0 | (73.7) | 36.0 | (91.4) | | | | |
| 22.0 | (55.9) | Not limited | | 33.0 | (83.8) | Not limited | | 0.060 | (1.52) | 0.063 | (1.60) |
| 25.0 | (63.5) | 31.0 | (78.7) | 35.0 | (88.9) | 43.0 | (109.2) | | | | |
| 25.0 | (63.5) | Not limited | | 39.0 | (99.1) | Not limited | | 0.067 | (1.70) | 0.070 | (1.78) |
| 29.0 | (73.7) | 36.0 | (91.4) | 41.0 | (104.1) | 51.0 | (129.5) | | | | |
| 33.0 | (83.8) | Not limited | | 51.0 | (129.5) | Not limited | | 0.080 | (2.03) | 0.084 | (2.13) |
| 38.0 | (96.5) | 47.0 | (119.4) | 54.0 | (137.2) | 66.0 | (167.6) | | | | |
| 42.0 | (106.7) | Not limited | | 64.0 | (162.6) | Not limited | | 0.093 | (2.36) | 0.097 | (2.46) |
| 47.0 | (119.4) | 59.0 | (149.9) | 68.0 | (172.7) | 84.0 | (213.4) | | | | |
| 52.0 | (132.1) | Not limited | | 80.0 | (203.2) | Not limited | | 0.108 | (2.74) | 0.111 | (2.82) |
| 60.0 | (152.4) | 74.0 | (188.0) | 84.0 | (213.4) | 103.0 | (261.6) | | | | |
| 63.0 | (160.0) | Not limited | | 97.0 | (246.4) | Not limited | | 0.123 | (3.12) | 0.126 | (3.20) |
| 73.0 | (185.4) | 90.0 | (228.6) | 103.0 | (261.6) | 127.0 | (322.6) | | | | |

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) Single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame, such as with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For a panel that is not supported along one side, for example, a panel of a box, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

## Table 30.2
## Minimum thickness of sheet metal for electrical enclosures of aluminum, copper, or brass

| Without supporting frame[a] | | | | With supporting frame or equivalent reinforcing[a] | | | | Minimum thickness, inches (mm) | |
|---|---|---|---|---|---|---|---|---|---|
| Maximum width[b] inches | (cm) | Maximum length[c] inches | (cm) | Maximum width[b] inches | (cm) | Maximum length inches | (cm) | | |
| 3.0 | (7.6) | Not limited | | 7.0 | (17.8) | Not limited | | 0.023 | (0.58) |
| 3.5 | (8.9) | 4.0 | (10.2) | 8.5 | (21.7) | 9.5 | (24.1) | | |
| 4.0 | (10.2) | Not limited | | 10.0 | (25.4) | Not limited | | 0.029 | (0.74) |
| 5.0 | (12.7) | 6.0 | (15.2) | 10.5 | (26.7) | 13.5 | (34.2) | | |
| 6.0 | (15.2) | Not limited | | 14.0 | (35.6) | Not limited | | 0.036 | (0.91) |
| 6.5 | (16.5) | 8.0 | (20.4) | 15.0 | (38.1) | 18.0 | (45.7) | | |
| 8.0 | (20.4) | Not limited | | 19.0 | (48.3) | Not limited | | 0.045 | (1.14) |
| 9.5 | (24.1) | 11.5 | (29.2) | 21.0 | (53.3) | 25.0 | (63.5) | | |
| 12.0 | (30.5) | Not limited | | 28.0 | (71.1) | Not limited | | 0.058 | (1.47) |
| 14.0 | (35.6) | 16.0 | (40.6) | 30.0 | (76.2) | 37.0 | (94.0) | | |
| 18.0 | (45.7) | Not limited | | 42.0 | (106.7) | Not limited | | 0.075 | (1.91) |
| 20.0 | (50.8) | 25.0 | (63.4) | 45.0 | (114.3) | 55.0 | (139.7) | | |
| 25.0 | (63.4) | Not limited | | 60.0 | (152.4) | Not limited | | 0.095 | (2.41) |
| 29.0 | (73.7) | 36.0 | (91.4) | 64.0 | (162.6) | 78.0 | (198.1) | | |
| 37.0 | (94.0) | Not limited | | 87.0 | (221.9) | Not limited | | 0.122 | (3.10) |
| 42.0 | (106.7) | 53.0 | (134.6) | 93.0 | (236.2) | 114.0 | (289.6) | | |
| 52.0 | (132.1) | Not limited | | 123.0 | (312.4) | Not limited | | 0.153 | (3.89) |
| 60.0 | (152.4) | 74.0 | (188.0) | 130.0 | (330.2) | 160.0 | (406.4) | | |

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) Single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame, such as with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For a panel that is not supported along one side, for example, a panel of a box, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

30.11 The criteria for judging an opening in an electrical enclosure are as specified in (a) and (b):

a) An opening that will not permit entrance of a 3/4-inch (19.1-mm) diameter rod is acceptable if:

1) A probe as illustrated in Figure 30.1 cannot be made to touch any uninsulated live part when inserted through the opening, and

2) A probe as illustrated in Figure 30.2 cannot be made to touch film-coated wire when inserted through the opening.

b) An opening that will permit entrance of a 3/4-inch diameter rod is acceptable under the conditions described in Figure 30.3.

**Figure 30.1**
**1/2 inch diameter probe for uninsulated live parts**

Figure 30.1 revised November 2, 1998

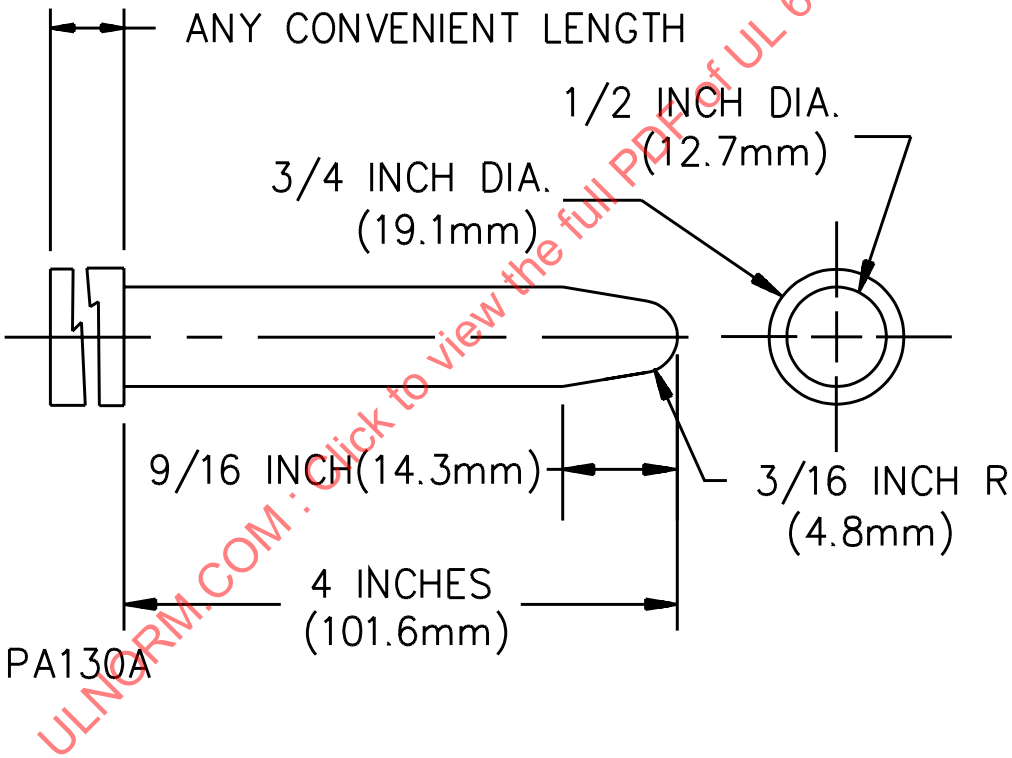


**Figure 30.2**
**1/2 inch diameter probe for film-coated wire**

Figure 30.2 revised November 2, 1998

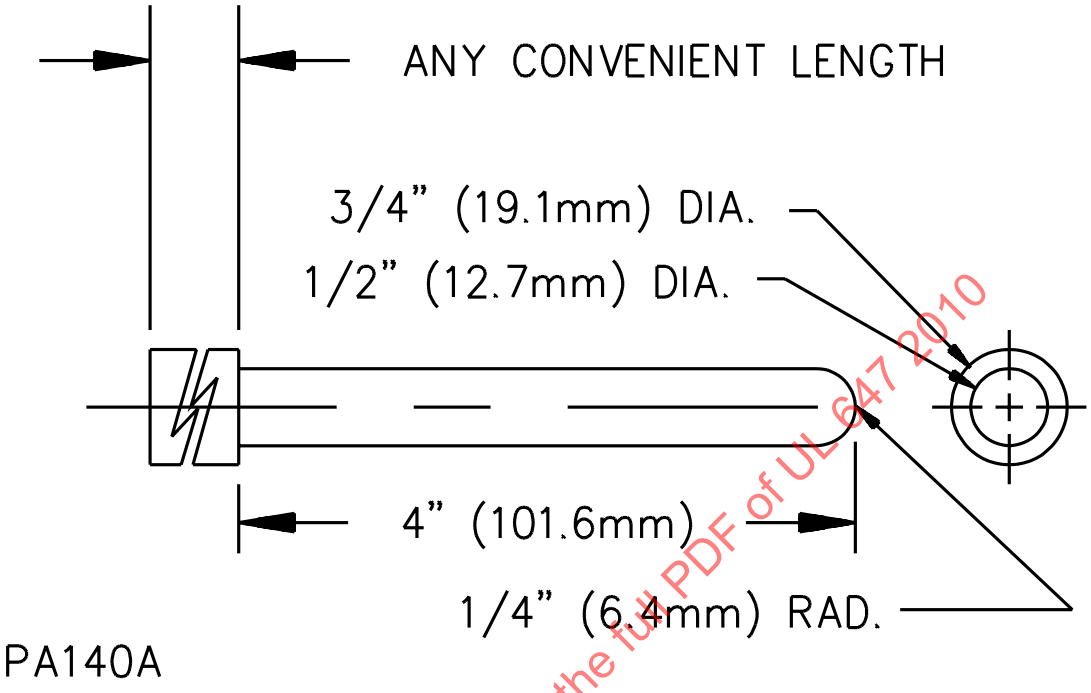


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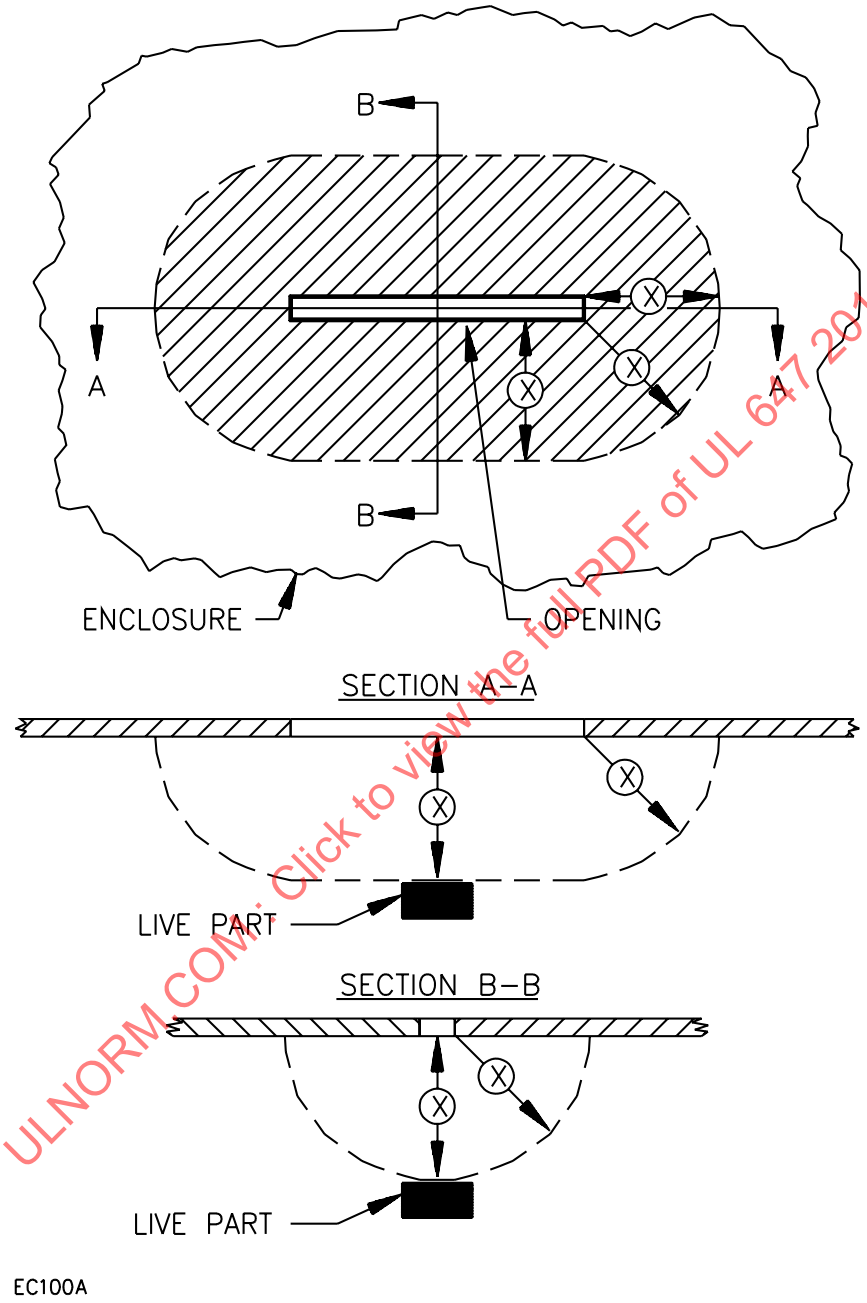
**Figure 30.3**
**Opening in enclosure**

Figure 30.3 revised November 2, 1998






The opening is acceptable if within the enclosure, there is no uninsulated live part or film-coated wire:

a) less than X inches (mm) from the perimeter of the opening, as well as

b) within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod that can be inserted through the opening, but not less than 4 inches (102 mm).

30.12 During the examination for compliance with the requirements of 30.11, any part of the enclosure (including air filters) that may be removed without the use of a tool is to be removed.

30.13 A cover or access panel of an enclosure for uninsulated high-voltage parts shall be provided with means for securing it in place.

30.14 A hinged or pivoted panel or cover shall be positioned or arranged so that it is not subject to falling or swinging from an open position due to gravity or vibration so as to cause injury to persons by the panel or cover, or by moving parts or uninsulated live parts.

30.15 The assembly shall be arranged so that an overcurrent-protective device, such as a fuse, the protective functioning of which requires renewal, can be replaced, and a manually reset can be reset without removing parts other than a service cover or panel, and a cover or door enclosing the device. See 30.19.

30.16 A required protective device shall be wholly inaccessible from outside the heater without opening a door or cover, except that the operating handle of a circuit breaker, the reset button of a manually reset motor protector, the reset button of a manually reset limit control, and similar parts may project outside the heater enclosure.

30.17 An opening in an enclosure to provide clearance around a dial, knob, lever, or handle shall not allow the entrance of a rod having a diameter of 9/64 inch (3.6 mm) at any setting or position of such part.

30.18 A fuseholder shall be constructed, installed, or protected so that adjacent uninsulated high-voltage live parts within 4 inches (102 mm), other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. An insulating barrier of vulcanized fiber or equivalent material employed for this purpose shall not be less than 0.028 inch (0.7 mm).

30.19 The door or cover of an enclosure shall be hinged if it gives access to fuses or any motor overload-protective device, the intended functioning of which requires renewal, or if it is necessary to open the cover in connection with the intended operation of the protective device, such as resetting a manually reset overload-protective device, except as indicated in 30.20.

30.20 A hinged cover is not required for a device in which the only fuses enclosed are:

a) Control-circuit fuses, provided the fuses and control-circuit loads (other than a fixed control-circuit load, such as a pilot lamp) are within the same enclosure,

b) Supplementary-type fuses of 2 amperes or less or small auxiliary resistance heaters with a maximum rating of 100 watts,

c) An extractor-type fuse with its own enclosure, or

d) Fuses in low-voltage circuits.

30.21 A hinged cover, where required, shall not depend solely upon screws or other similar means requiring the use of tools to hold them closed, but shall be provided with a catch or spring latch.

30.22 A spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the door in place and would require some effort to open it is considered to be an acceptable means for holding the door in place as required in 30.21.

30.23 A door or cover giving direct access to fuses in other than low-voltage circuits shall shut closely against a 1/4-inch (6.4 mm) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction that affords equivalent protection, such as a fuse enclosure within an outer enclosure, or a combination of flange and rabbet, is acceptable.

30.24 A strip used to provide rabbets, or an angle strip fastened to the edges of a door, shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip, and at points between these end fastenings not more than 6 inches (152 mm) apart.

30.25 An electron tube or similar glass-enclosed device shall be protected against mechanical damage.

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## 31 Motors And Motor (Overload) Protection

31.1 A motor shall be protected by an integral thermal protector or an overload-protective device, or combination thereof.

31.2 An overload-protective device as referred to in 31.1 means one that complies with the requirements in the National Electrical Code, ANSI/NFPA 70-1999, as follows:

a) A separate overload device that is responsive to motor current. This device shall be rated or selected to trip at no more than the following percent of the motor full-load current rating:

1) Motors with a marked service factor not less than 1.15, 125 percent;

2) Motors with a marked temperature rise not over 40°C (72°F), 125 percent; and

3) All other motors, 115 percent.

For a multispeed motor, each winding connection shall be considered separately and the motor is to be protected at al speeds.

b) If the values specified for motor-running overload protection do not correspond to the percentage value of a magnetic or thermal overload relay of a standard size, the next higher size may be used, but not higher than the following percent of motor full-load current rating:

1) Motors with a marked service factor not less than 1.15, 140 percent;

2) Motors with a marked temperature rise not over 40°C (72°F), 140 percent; and

3) All other motors, 130 percent.

31.2 revised January 26, 2000

31.3 An integral thermal-protective device shall comply with the Standard for Overheating Protection for Motors, UL 2111.

31.3 revised November 2, 1998

31.4 A separate overload device, except when included as part of a magnetic motor controller, shall be assembled as part of the equipment and be identifiable as such after assembly to the equipment. Such protection shall not include means for manually interrupting the motor circuit if such interruption may allow operation of the equipment that can cause risk of fire or electric shock.

31.5 A motor shall be of the totally enclosed construction if not wholly enclosed within the heater casing.

31.6 In determining compliance with 31.5, when a totally enclosed motor is to be provided, there shall be no openings in portions of the motor frame exterior of the heater, that is, openings may be in the shaft end of face-mounted oil-burner motors bolted flush to the blower housing of an oil burner, but not in other portions of the motor frame.

31.7 A motor, such as a direct-drive fan motor that is not normally subjected to overloads, and that is determined to be adequately protected against overheating due to locked-rotor current by a thermal- or overcurrent-protective device, is acceptable, provided it is determined that the motor will not overheat under actual conditions of use.

31.8 Impedance protection may be accepted for motors that are determined to be adequately protected against overheating due to locked-rotor current, provided it is determined that the motor will not overheat during the Impedance-Protected Motor – Locked Rotor Test, Section 67.

31.9 A fuse shall not be used for motor overload-protection unless the motor is adequately protected by the largest size fuse that can be inserted in the fuseholder.

31.10 A motor shall not exceed the temperature rises specified in Table 48.1 when tested as specified in the Temperature Test, Section 48.

31.11 In no case shall interruption of the circuit to a motor by the overcurrent- or overtemperature-protective device result in unintended operation of the heater or the discharge of fuel. If a burner depends solely upon an electric valve to stop the flow of fuel to the burner, the interruption of the circuit to the motor by the protective device shall also cause the interruption of the circuit to the valve.

31.12 An automatic-reset type protective device shall not be used if the automatic reclosing of the circuit to the motor by the device may result in unintended operation of the heater.

31.13 The enclosure of a motor shall have no openings that will permit a drop of liquid or a particle falling vertically onto the motor to enter the motor as applied to the assembly.

31.14 Compliance with 31.13 may be provided by the motor frame or by another enclosure, structure, shield, or a combination of two or more such items, and is to be determined with the motor when assembled with the heater.

31.15 A motor having openings in the enclosure or frame shall be installed or shielded to reduce the risk of particles falling out of the motor onto flammable material located within or under the assembly.

31.16 The requirement in 31.15 will necessitate the use of a barrier of nonflammable material under an open-type motor unless:

a) The structural parts of the motor or the heater such as the bottom closure, provided the equivalent of such a barrier;

b) The motor overload-protection device provided with a single-phase motor is such that no burning insulation or molten material falls to the surface that supports the heater when the motor is energized under each of the following fault conditions, as applicable to the particular type of motor:

1) Open main winding,

2) Open starting winding,

3) Starting switch short-circuited, and

4) Capacitor shorted, permanent split capacitor type; or

c) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) that will prevent the temperature of the motor windings from becoming more than 257°F (125°C) under the maximum load below which the motor will run without causing the protector to cycle and from becoming more than 302°F (150°C) with the rotor of the motor locked; or

d) The motor complies with the requirements specified in the Impedance-Protected Motors – Locked-Rotor Test, Section 66.

31.16 revised January 26, 2000

31.17 The barrier mentioned in 31.16 shall:

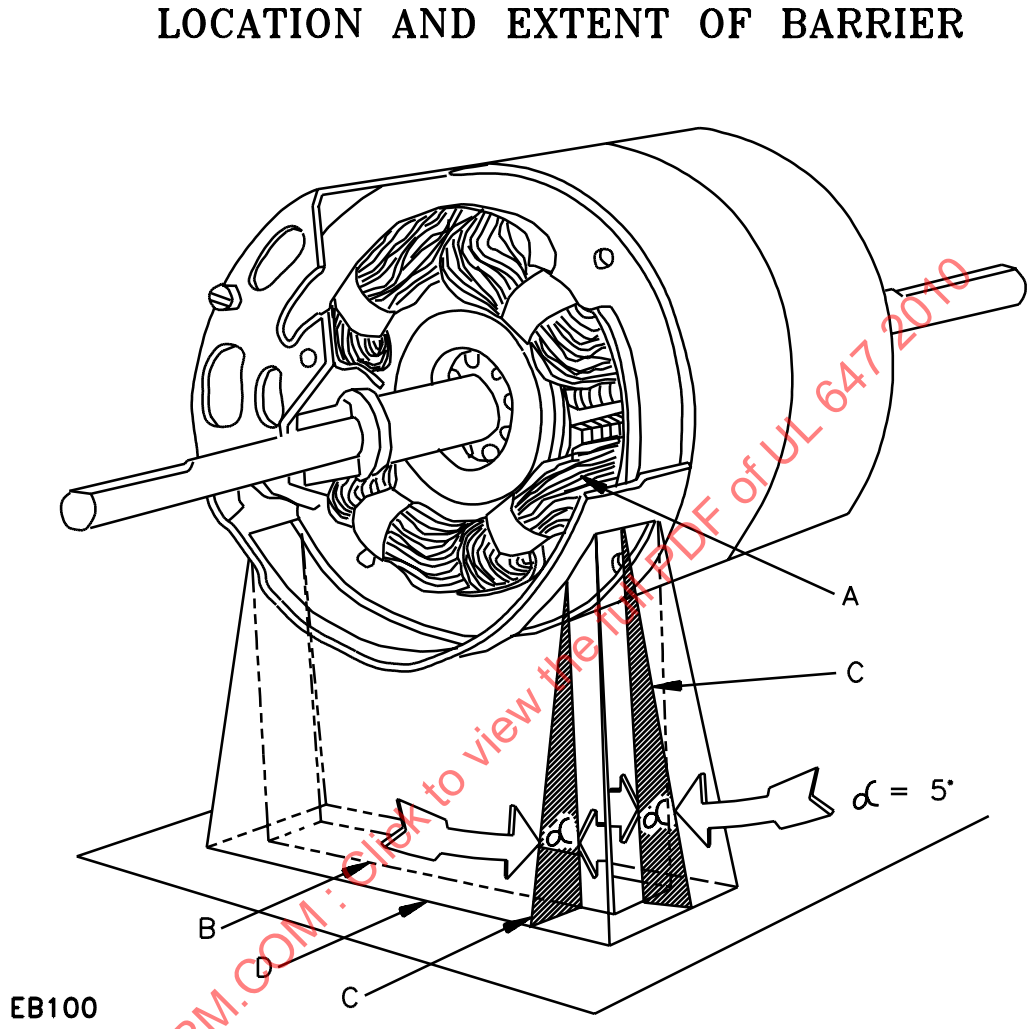
a) Be horizontal,

b) Be located as illustrated in Figure 31.1, and

c) Have an area not less than that described in that figure. Openings for drainage and ventilation may be employed in the barrier, provided that such openings would not permit molten metal, burning insulation, or the like, to fall on flammable material.

**Figure 31.1**
**Location and extent of barrier**

Figure 31.1 revised November 2, 1998






A – A motor winding to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding that is partially shielded by the motor enclosure or equivalent.

B – Projection of outline of motor winding on horizontal plane.

C – Inclined line that traces out minimum area of the barrier. When moving, the line is to be always:

a) tangent to the motor winding,

b) 5 degrees form the vertical, and

c) so oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is to be that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

31.18 Thermal-protective devices for motors shall comply with the Standard for Overheating Protection for Motors, UL 2111.

31.18 revised November 2, 1998

## 32 Switches And Controllers

32.1 A controller or switch used in the heater shall be rated for the load that it controls.

32.2 A controller that may be called upon to break a motor load under locked-rotor conditions shall have a current-interrupting capacity not less than the locked-rotor load of the motor controlled.

32.3 If the controller is cycled by the operation of an automatic-reset overload device, it is to withstand an endurance test under locked-rotor conditions without malfunction. The endurance test is to be of a duration equivalent to that required for the overload device and at an equivalent rate.

## 33 Capacitors

33.1 A motor-starting or -running capacitor shall be housed within an enclosed or container that will protect the plates against mechanical damage and that will prevent the emission of flame or molten material resulting from malfunction of the capacitor. Except as noted in 33.2 and 33.3, the container shall be of metal providing strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.01 mm).

33.2 The individual container of a capacitor may be of material other than metal if the capacitor is mounted in an enclosure that houses other parts of the heater and provided that such box or case is acceptable for the enclosure of current-carrying parts.

33.3 If the container of an electrolytic capacitor is constructed of metal, it shall be insulated from dead metal parts in accordance with the requirements in Table 35.1.

33.4 A capacitor employing a liquid dielectric medium more combustible than askarel shall be protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements in this standard, including faulted overcurrent conditions based on the circuit in which it is used.

*Exception: If the available fault current is limited by one or more other components in the circuit, such as a motor start winding, the capacitor may be tested using a fault current established by dividing the rated circuit voltage by the impedance of the other component or components.*

## 34 Electrical Insulating Material

34.1 Material used for the sole support, separation, or both, of current-carrying parts shall be of moisture resistant material, such as porcelain, phenolic, or cold-molded composition.

34.2 Vulcanized fiber may be used for the insulating bushings, washers, separators, and barrier, but not as the sole support for uninsulated live parts of other than low-voltage circuits.

SPACINGS

## 35 High-Voltage Circuits

35.1 Except as noted in 35.2 – 35.4, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall not be less then the applicable values specified in Tables 35.1 and 35.2.

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35.2 The through-air and over surface spacings at an individual component part are to be evaluated on the basis of the total volt-amperes consumption of the load or loads that the component controls. However, the spacing from the component to the enclosure shall be evaluated on the basis of the total load on all components in the enclosure. For example, the through-air and over-surface spacings at a component which controls only a motor are elevated on the basis of the volt-amperes of the motor. A component that controls loads in addition to the motor is similarly evaluated on the basis of the sum of the volt-amperes of the loads so controlled; except that a component that independently controls separate loads is evaluated on the basis of the volt-amperes of the larger load. The volt-ampere values for the load referred to above are to be determined by the measured input.

35.3 The spacing requirements in Table 35.1 and 35.2 do not apply to the inherent spacings inside a motor, except at wiring terminals, or to do the inherent spacings of a component that is evaluated on the basis of the requirements for the component. However, the electrical clearance resulting from the installation of a component, including clearances to dead metal or enclosures, shall be those specified.

**Table 35.1**
**Minimum acceptable spacings in safety circuits and at field wiring terminals**

| Ratings | | Through air | | Minimum spacings[a] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Over surface | | To enclosure[c] | |
| Volt-amperes | Volts | Inch | mm | Inch | mm | Inch | mm |
| 0 – 2000 | 0 – 300 | 1/8[b] | 3.2 | 1/4 | 6.4 | 1/4 | 6.4 |
| More than 2000 | 0 – 150 | 1/8[b] | 3.2 | 1/4 | 6.4 | 1/2 | 12.7 |
| | 151 – 300 | 1/4 | 6.4 | 3/8 | 9.5 | 1/2 | 12.7 |

[a] An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material employed where spacings would otherwise be insufficient, shall not be less than 0.028 inch (0.71 mm) thick, except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through air spacing required. The liner shall be located so that it will not be damaged by arching. Material having a lesser thickness may be used if it has equivalent insulation, mechanical, and flammability properties.

[b] The spacings between wiring terminals of opposite polarity, or between a wiring terminal and grounded metal, shall not be less than 1/4 inch (6.4 mm), except that if short-circuiting grounding of such terminals will not result from projecting strands of wire, the spacing need not be greater than that specified in the table. Wiring terminals are those connected in the field and not factory wired. Measurements are to be made with solid wire of adequate ampacity for the load connected to each terminal.

[c] Includes fittings for conduit or metal-clad cable.

35.4 All uninsulated live parts connected to different circuits, except subdivided circuits or branch circuits of same voltage from same feeder, shall be spaced from one another as though they were parts of opposite polarity in accordance with the requirements in 35.1 – 35.3 and shall be evaluated on the basis of the highest voltage involved.

35.5 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material employed where spacings would otherwise be insufficient, shall be not less than 0.028 inch (0.7 mm) thick; except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through-air spacing required. The liner shall be located so that it will not be damaged by arcing.

*Exception: Thinner material may be used if it has equivalent insulating, mechanical, and flammability properties.*

**Table 35.2**
**Minimum acceptable spacings at other than safety circuits or field wiring terminals[a]**

| Parts involved | Potential involved, volts | Through air and over surface | |
|---|---|---|---|
| | | inch | mm |
| Between uninsulated live metal parts of opposite polarity; and between a rigidly mounted uninsulated live metal part and a dead metal part other than the enclosure that either is exposed for persons to contact or may be grounded | 0 – 250 | 1/16 | 1.6 |
| | 251 – 600 | 1/4[b,c] | 6.4[b,c] |
| Between uninsulated live metal parts and the metal enclosure | 0 – 600 | 1/4[c] | 6.4[c] |

[a] If an uninsulated live metal part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live metal part, the construction shall be such that at least the minimum acceptable spacing is maintained under all operating conditions and under all normal conditions of handling.

[b] Film-coated insulated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch (2.4 mm) over surface and through air is acceptable between a noncurrent carrying metal part and film-coated insulated wire rigidly supported and held in plact on a motor coil.

[c] For a circuit not exceeding 300 volts, the over surface spacings for glass-insulated terminals of motors may be 1/8 inch (3.2 mm).

## 36 Isolated-Limited-Secondary Circuits

### 36.1 Safety circuits

36.1.1 If short-circuiting of parts in a safety control circuit of an isolated-limited-secondary circuit will not increase the risk of fire, electric shock, or injury to persons by the controlled equipment, the spacings may be less than the value specified in Table 35.1 but no less than the applicable value specified in Table 36.1.

### 36.2 Other than safety circuits

36.2.1 Spacing between uninsulated live parts of opposite polarity and between such parts and dead metal that may be grounded in service is not specified for an isolated-limited-secondary circuit. The spacing is based on acceptable performance of the heater during applicable dielectric voltage-withstand and abnormal operation tests.

**Table 36.1**
**Minimum acceptable spacings in safety circuits in isolated-limited-secondary circuits**

| Spacing between uninsulated live parts and | | Potential involved (volts) | | | |
|---|---|---|---|---|---|
| | | 0 – 600 | | 601 – 1000 | |
| | | Inch | mm | Inch | mm |
| A. Exposed isolated (insulated) dead metal part | Through air | 1/8 | 3.2 | 1/4 | 6.4 |
| | over surface | 1/4 | 6.4 | 3/8 | 9.5 |
| B. Grounded dead metal part other than the enclosure | Through air | 1/16 | 1.6 | 3/16 | 4.8 |
| | over surface | 1/16 | 1.6 | 3/16 | 4.8 |
| C. Uninsulated live part of opposite polarity | Through air | 1/16 | 1.6 | 3/16 | 4.8 |
| | over surface | 1/16 | 1.6 | 3/16 | 4.8 |
| D. Wall of metallic enclosure | Through air | 1/4 | 6.4 | 1/2 | 12.7 |
| | over surface | 1/4 | 6.4 | 1/2 | 12.7 |

## 37 Low-Voltage Circuits

37.1 The spacings for low-voltage electrical components that are installed in a circuit that includes a motor overload-protective device, or other protective device, where a short or grounded circuit may result in operation of the heater that causes a risk of fire or electric shock, shall comply with 37.2 – 37.5.

37.2 The spacing between an uninsulated live part and the wall of a metal enclosure including fittings for the connection of conduit or metal-clad cable shall not be less than 1/8 inch (3.2 mm).

37.3 The spacing between wiring terminals, regardless of polarity, and between the wiring terminal and a dead metal part (including the enclosure and fittings for the connection of conduit) that may be grounded when the device is installed, shall not be less than 1/4 inch (6.4 mm).

37.4 The spacing between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part, other than the enclosure, that may be grounded when the device is installed, shall not be less than 1/32 inch (0.8 mm), provided that the construction of the parts is such that spacings will be maintained.

37.5 The spacings in low-voltage circuits that do not contain devices such as indicated in 37.1 are not specified.

## PERFORMANCE

## 38 General

38.1 A heater shall comply with the applicable requirements when tested as described herein in an ambient of 75.0 ±9.0°F (23.9 ±5.0°C). A heater of a type not described specifically herein shall be tested in accordance with the intent of these requirements.

38.2 The performance of a heater is to be evaluated upon the basis of operation tests conducted on the heater. Heaters of each size and type, or a sufficient number of sizes and types to be representative of the entire range of sizes and types involved, are to be subjected to all or part of the tests prescribed herein. If optional features affecting performance are furnished, a heater is to be tested with each such optional equipment.

38.3 A heater, when tested in accordance with these requirements, shall operate free from excessive carbonization or other phenomena that may increase the risk of fire or explosion.

38.4 If any indications are observed during the tests prescribed herein that a heater will not continue to comply with the requirements in intended usage so as to provide for continued performance, such supplementary tests shall be conducted as deemed necessary to determine compliance.

38.5 Wherever use of cheesecloth is specified for use in a test (see Sections 48 and 50 – 54) bleached cheesecloth is to be used as specified in 38.6.

38.6 Bleached cheesecloth is to be 36 inches (910 mm) wide, running 14 – 15 yards per pound (28 – 30 m/kg), and having what is known to the trade as a count of 32 x 28; that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

38.7 Synthetic Fuels and the suitability of their use in the heater is to be evaluated in accordance with the Outline of Investigation for Synthetic Fuels for Listed Kerosene-Fired Portable Heaters and Kerosene-Fired Room Heaters, Subject 647A.

38.7 revised April 16, 2010

## 39 Instrumentation

### 39.1 Fuel input

39.1.1 A fuel-metering valve is to be tested for flow rates using apparatus similar to that illustrated in Figures 39.1 – 39.3. The temperature of the kerosene is to be 70 – 80°F (21 – 27°C). The flow rate may vary 2 cubic centimeters for plus or minus 10°F (5.6°C) variation from 75°F (23.9°C). The flow from a temperature-compensated valve may decrease as the temperature increases.

39.1.1 revised January 26, 2000

39.1.2 With the valve open to the setting to be checked, kerosene is to be allowed to flow through the system for about 5 minutes to purge it of air. With the kerosene flowing as intended, that discharging from the valve under test is to be retained over a measured period to determine the flow. To reduce errors, the measurement of flow is to be continued for 3 – 4 minutes at each valve setting and is to be repeated two or more times before concluding the test.

## 39.2 Temperature measurement

39.2.1 Temperatures are to be measured by thermocouples except that the change-of-resistance method may be used to measure the temperature of motor windings or of coils. The thermocouples shall consist of wires not larger than 24 AWG (0.21 $mm^2$) and not smaller than 30 AWG (0.05 $mm^2$). The thermocouple wire shall conform to the requirements listed in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

39.2.1 revised April 16, 2010

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**Figure 39.1**
**Flow-rate test**

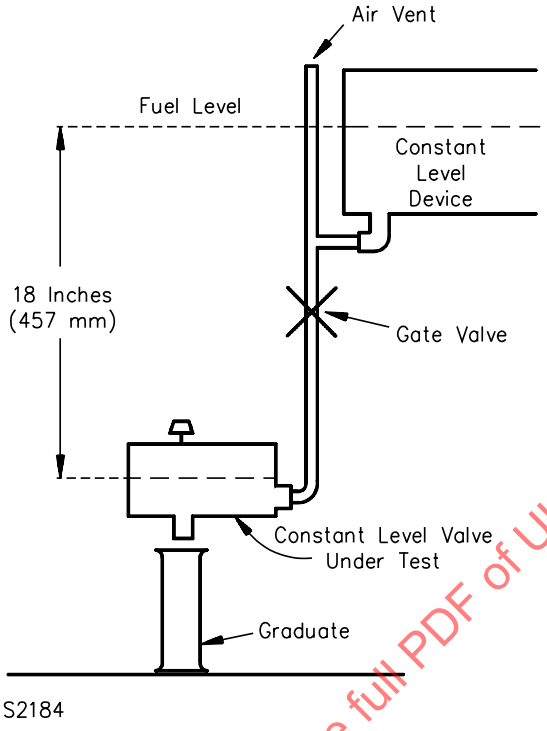



**Figure 39.2**
**Flow-rate test**

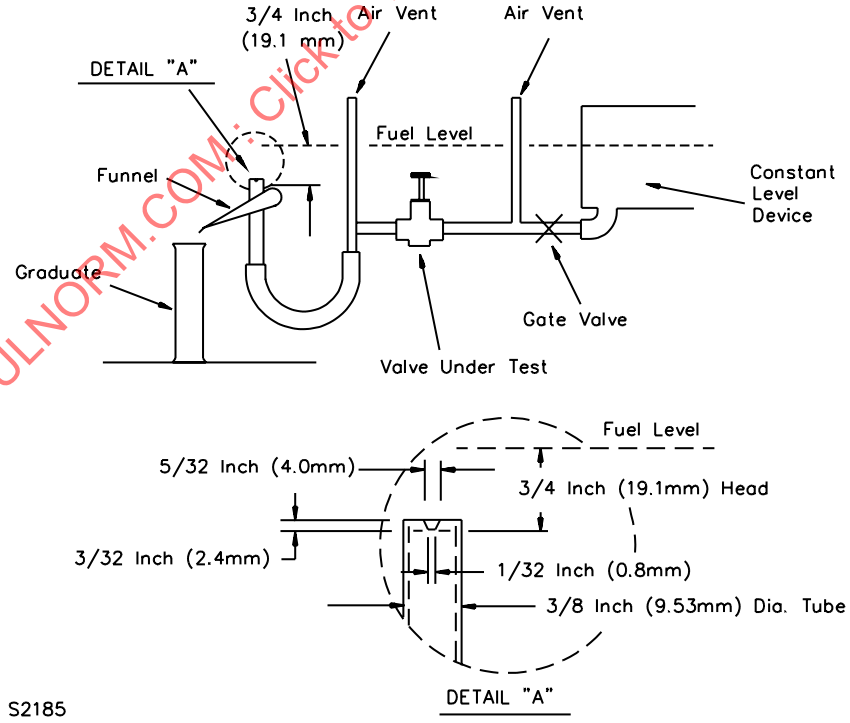
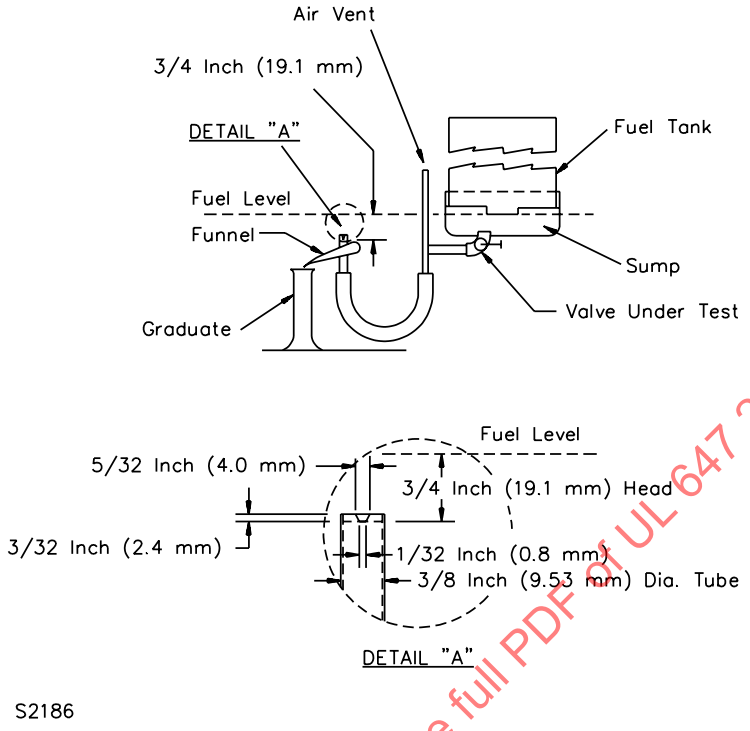


**Figure 39.3**
**Flow-rate test**




S2186

39.2.2 Where thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, it is a standard practice to employ thermocouples consisting of 30 AWG (0.05 $mm^2$) iron and constantan wires and a potentiometer type of indicating instrument. This equipment is to be used whenever referee temperature measurements by means of thermocouples are necessary.

39.2.2 revised April 16, 2010

39.2.3 Thermocouples are to be placed on the surface of the test enclosure at various locations as may be required to observe maximum temperatures during tests. Thermocouples are to be attached to other pertinent materials and parts such as those described in Table 48.1.

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

39.2.5 Thermocouples are to be secured to wood surfaces by staples over the insulated portion of the wire and with the tip held in a thermal contact with the surface by pressure-sensitive tape; except that for zero clearance, the thermocouples are to be applied to surfaces of the heater at points of zero clearance.

39.2.6 Thermocouples are to be attached to surfaces other than as described in 39.2.5 by being cemented or taped to the surface in a manner to assure thermal contact with the surface.

39.2.7 A temperature is considered to be constant when three successive readings, taken at intervals of 15 minutes indicate no increase in temperature rise at observed maximum temperature points.

39.2.8 Room ambient temperature is to be measured by a thermometer or thermocouple located as indicated in Figure 40.1.

39.2.9 The outlet air temperature at a forced air outlet opening is to be measured using an air temperature grid. The grid is to consist of five thermocouples of identical length that are wired in parallel to form a grid having one thermocouple located in the center of the outlet air opening and one in the center of each four equal air outlet opening areas in a plane perpendicular to the axis of air flow. The grid is to be located 1 inch (25.4 mm) downstream from the plane of the outlet air opening.

**39.3 Power measurement**

39.3.1 The total electrical input to a heater is to be measured in amperes.

39.3.2 An electrical meter is to have a maximum scale range of not more than 1-1/2 times the value to be measured. The smallest scale division is to be not more than 1/50 of the maximum scale range.

**39.4 Flue-gas analysis**

39.4.1 The concentration of carbon monoxide in flue gases is to be measured by means of an infrared analyzer or other equivalent instruments.

39.4.2 A hood with a mixing chamber, constructed as illustrated in Figures 39.4 and 39.5, employing a probe as illustrated in Figure 39.6, is to be used to collect combustion products for analysis in accordance with 43.8 – 43.10. The hood is to be 24 inches (609.6 mm) by 30 inches (762 mm) in dimension. The longitudinal axis of the probe is to be parallel with the 24 inch (609.6 mm) dimension of the hood, and perpendicular to the 30 inch (762 mm) of the hood. The hood, the mixing chamber, the probe and the tubing and connectors between the probe and the nitrogen dioxide instrument shall be of materials such as aluminum, stainless steel and teflon that do not adsorb nitrogen dioxide.

39.4.3 The concentration of nitrogen dioxide in the combustion products is to be measured by means of a chemiluminescent type or equivalent instrument that has a rated accuracy of not more than plus or minus 2 percent and rated precision not more than plus or minus 1 percent. The sample shall not pass through a cold trap.

**Figure 39.4**
**Hood assembly**

Added Figure 39.4 effective August 19, 1994

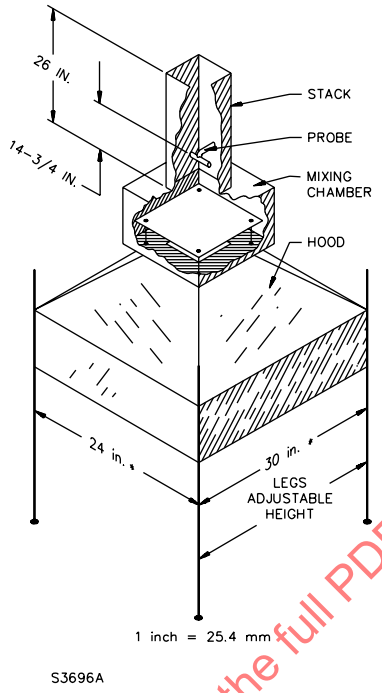



**Figure 39.5**
**Mixing chamber**

Added Figure 39.5 effective August 19, 1994

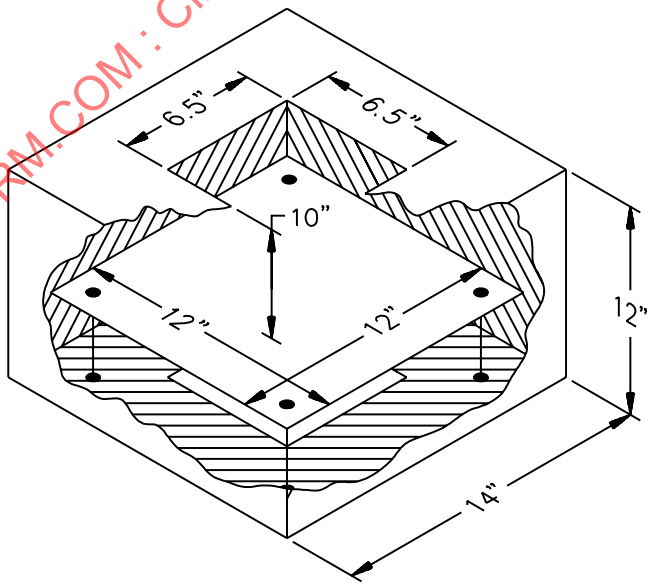
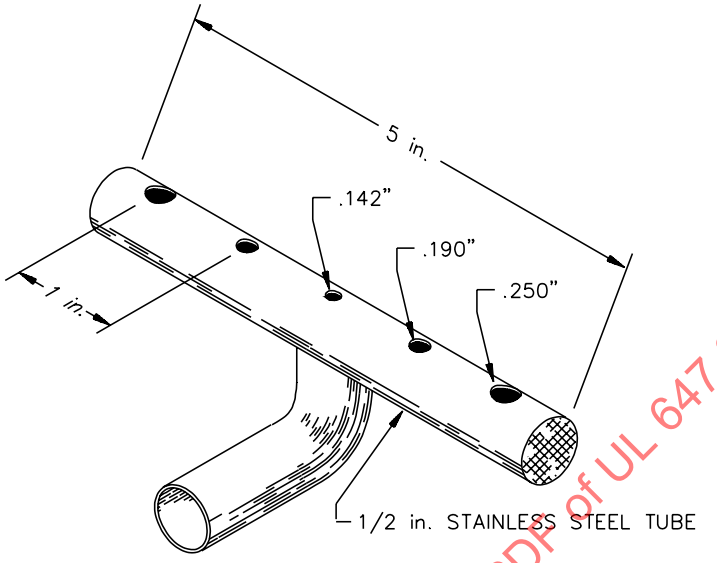


**Figure 39.6**
**Multiport sample probe**

Added Figure 39.6 effective August 19, 1994




1 inch = 25.4 mm

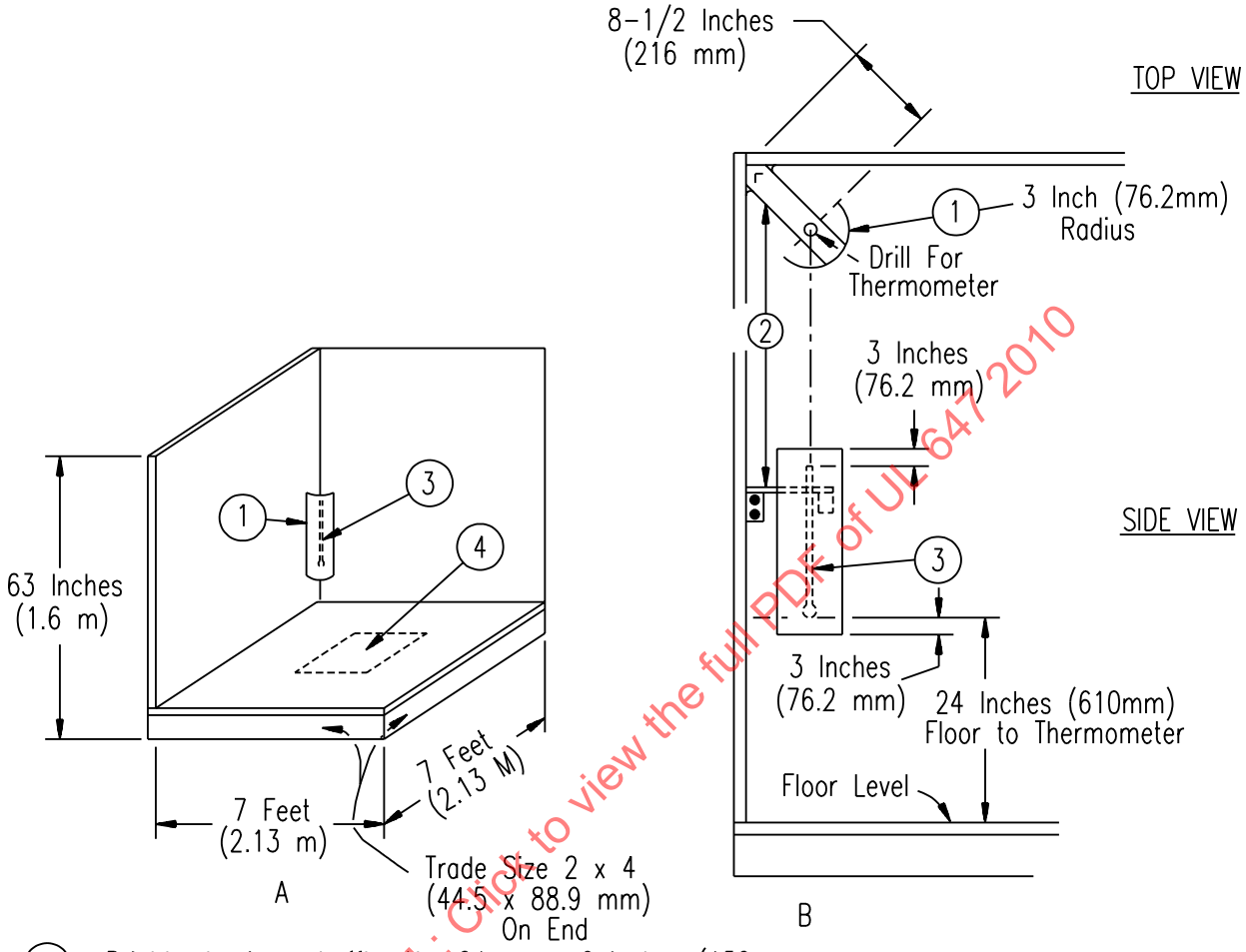
S3698

## 40 Test Installation

40.1 The walls of the test enclosure, see Figure 40.1, are to be made of nominal 1-inch tongue-and-groove pine boards or 3/4-inch thick plywood finished in dull black. The walls are to be set at right angles to each other and perpendicular to the floor. The floor is to be made of nominal 1-inch white pine covered with one thickness of building paper and then by nominal 1-inch tongue-and-groove oak flooring finished with a clear varnish. All joints in the enclosure are to be tightly sealed.

**Figure 40.1**
**Enclosure for heaters**

Figure 40.1 revised November 2, 1998




1. Bright-aluminum baffle, No. 24 gage, 6 inches (152 mm) longer than item 3.
2. Bracket material, 1/8 by 1 inch (3.2 by 25.4 mm) angle and 1/8 by 1 inch strap iron.
3. Thermometer supported by bracket, or thermocouple.
4. Location of heater on platform.

S2187

## 41 Tank-Capacity

41.1 For all tests that specify a full fuel tank, the tank is to be filled in accordance with 41.2.

41.2 With respect to the requirement in 20.1, the capacity of an integral or removable fuel tank of a portable heater is to be determined by measuring the amount of fuel that can be poured into the tank through its fill opening before it overflows from the fill opening. For this test the heater is to be located on a level surface and the kerosene is to be at a temperature of 65 ±10°F (18 ±6°C).

## 42 Fuel-Consumption-Rate Test

42.1 The average maximum Btu per hour consumption rate of a room heater or portable heater used for tests in these requirements shall not differ from the marked input rating of the heater by more than 10 percent (see 71.1(d)). In addition, for a portable heater the average consumption rate shall not exceed 25,000 Btu (26.38 MJ) per hour; for a room heater, the average consumption rate shall not exceed 30,000 Btu (31.65 MJ) per hour.

42.2 The fuel tank of a heater is to be filled with fuel and allowed to stand at room temperature for at least 4 hours. The heater then is to be operated at its maximum burner setting until the flame stabilizes (approximately 1/2-hour). Following this, the heater is to be operated for at least 4 hours but not longer than 5 hours at the maximum burner setting, and the amount of fuel consumed during this period is to be determined by weight or volume within an accuracy of 2 percent. The average fuel consumption rate in Btu's per hour is then to be calculated, based on the caloric value of kerosene being 19,810 Btu's (20.90 MJ) per pound or 134,700 Btu's (142.11 MJ) per gallon.

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42.3 The test described in 42.2 is to be repeated with the burner adjusted at the minimum limit of the self-latching wick stop. The average fuel consumption rate that is measured is to be used to calculate the maximum allowable carbon monoxide concentration specified in 43.10(b)(2).

## 43 Combustion Tests

43.1 Combustion shall be stable and complete at all burner settings of the burner adjustment means provided on the heater. See 43.10.

43.2 To determine compliance with 43.1, the heater is to be observed for a stable burner flame. Samples of the combustion products are to be analyzed for maximum smoke density and for carbon monoxide and carbon dioxide concentration in accordance with 43.3 – 43.10.

43.3 The heater is to be arranged for operation in accordance with the instructions furnished with the heater and in an area free of drafts. The heating surfaces of the heater are to be clean and free of soot and dust at the beginning of the test.

43.4 Each burner of a heater is to be operated at the minimum permissible setting (see 43.5) until the flame becomes stabilized and all parts of the heater reach equilibrium temperatures. Each burner is then to be adjusted as rapidly as possible to the maximum setting permitted by the adjustment means and the heater is to be observed for flame flare-up (see 43.10(e)).

43.5 The minimum permissible setting for the tests specified in 43.4 and 43.8 is to be the minimum setting of the wick allowed by the wick stop described in accordance with 14.3.

43.6 The test specified in 43.4 is to be repeated at least twice with the burner initially adjusted to other than the minimum permissible setting. Additional tests are to be conducted if it appears that some other initial settings may cause the burner flame to flare up when the burner is rapidly adjusted to the maximum firing position.

43.7 A heater that employs a vacuum-feed tank is also to be operated at the maximum setting permitted by the burner adjustment until all parts of the heater are at equilibrium temperatures. Kerosene is then to be added to the sump up to the overflow level and is to be maintained at that level for 1/2 hour by adding additional kerosene, as necessary. The heater is to be observed for a stable flame. See 43.10(e).

43.8 For all heaters, samples of the combustion products are to be analyzed for smoke density and carbon monoxide (CO), carbon dioxide ($CO_2$), and nitrogen dioxide ($NO_2$) concentrations while the heater is operated at the minimum burner setting (see 43.5), and at the maximum burner setting permitted by the adjustment means. A hood and stack assembly, constructed as described in 39.4.2 and shown in Figures 39.4 and 39.5, is to be used to collect samples of the combustion products. The hood is to be placed level over the heater and adjusted for height so that the lower edge of the hood is at the same heights as the top of the heater. In the horizontal plane, the hood is to be placed so that its results in the highest concentration of the combustion products in the stack.

Revised 43.8 effective August 19, 1994

43.9 Samples of the combustion products are to be collected by the appropriate instruments (see 39.4.1 – 39.4.3) through the probe in the stack using vacuum pumps, tubing, and fittings as necessary (see 39.4.2). To minimize the possibility of adsorption of nitrogen dioxide the tubing between the probe and the nitrogen dioxide instrument should be of minimum practical length. Consideration can be given to heating the tubing so as to retain the temperature of the flue gases above dew point temperature of approximately 140 – 150°F (60 – 66°C).

Revised 43.9 effective August 19, 1994

43.10 Each test shall be continued for at least 30 minutes during which time the amount of kerosene consumed by the heater shall be accurately monitored by weight to the nearest gram.

Added 43.10 effective August 19, 1994

43.11 When tested in accordance with 43.3 – 43.10, the heater shall perform as follows:

a) A stable flame shall be obtained over the entire range of burner adjustments marked on the heater and following rapid increases in burner settings. A heater employing a vacuum-feed tank shall have a stable flame when the sump is filled to the overflow level.

b) The carbon monoxide concentration in an air-free sample of the combustion products [$CO_{(air-free)}$] shall not exceed:

1) 0.04 percent when the heater is operated at the maximum burner setting permitted by the adjustment means. The concentration is to be calculated according to the following equation:

$$CO_{(air-free)} = \frac{U}{CO_2}(CO)$$

*In which:*

*U is the ultimate concentration of carbon dioxide for the fuel being burned in percent. For kerosene, 15.4 percent is to be used.*

*$CO_2$ is the measured concentration of carbon dioxide in combustion products in percent, and*

*CO is the measured concentration of carbon monoxide in combustion products in percent.*

2) 0.08 percent when calculated using the formula specified in item 1, or the value calculated by the following equation, whichever is less, when the heater is operated at the minimum burner setting (see 43.5):

$$CO_{(air-free)} = \frac{I_{max}}{I_{min}}(0.04)$$

*In which:*

*$I_{max}$ is the maximum fuel-consumption rate (see 42.2), and*

*$I_{min}$ is the minimum fuel-consumption rate (see 42.3).*

c) The $NO_2$ emission rate for unvented kerosene-fired room heaters and unvented kerosene-fired portable heaters, at all allowable wick adjustment settings between the minimum and maximum wick stops, shall not exceed 0.005 cc/Kj. The nitrogen dioxide ($NO_2$) emission rate shall be calculated in cc/Kj by the following equation:

$$\frac{U}{CO_2} \; NO_2 \text{ emission rate } (cc/Kj) = \text{x } NO_2 \, (ppm) \text{ x } 2.285 \text{ x } 10^{-4} \; cc/Kj$$

*In which:*

*U and $CO_2$ are as defined in (b).*

*$NO_2$ (ppm) is the measured concentration of $NO_2$ in combustion products in parts per million.*

*2.285 x $10^{-4}$ cc/Kj is a coefficient which by theoretical application of the gas laws and molecular weight of $NO_2$ converts the emission rate into cc/Kj.*

d) No excess carbon, soot, or tar shall be deposited on surfaces of heat exchangers or in vaporizers of burners. Any accumulation is to be deemed excessive if it:

1) Is likely to be deleterious to the performance of the burner;

2) Continually increases as the test progresses;

3) Reduces the area of air openings in burners; or

4) Restricts the fuel input more than 10 percent.

e) No flames shall extend beyond:

1) The heater casing; or

2) The guard or grille of a heater if a heater casing is not provided.

f) When the heater is operated at minimum and maximum burner setting and until steady-state combustion conditions of draft, fuel-input rate, and temperature have been established, the smoke in the combustion products shall not exceed that indicated by a number 1 spot on the Shell-Bacharach scale with the Model RDC smokemeter.

43.11 revised January 26, 2000

## 44 Stability Test

44.1 When a room heater is tipped in any direction, the angle through which the heater must be tilted before falling of its own accord shall exceed 20 degrees when tested in accordance with 44.3 – 44.6.

44.2 When a portable heater is tipped in any direction, the angle through which the heater must be tilted before falling of its own accord shall exceed 33 degrees when the heater is tested in accordance with 44.3 – 44.6.

44.3 The heater is to be placed on a level floor or platform. If leveling means are provided as part of the heater, the heater is to be raised to the highest position allowed by the leveling means.

44.4 A heater equipped with an integral or removable fuel tank is to be tested when the tank is full and when the tank is empty.

44.5 The tipping angle is to be the angle included within the plane of the base of the heater and the plane of the floor when the heater is tipped to the least position from which it will fall on its side when released.

44.6 The heater base or legs are to be blocked on the side opposite to the point to which the force is applied so that the heater will not slide. The tipping force is to be applied until the position is reached at which the heater will tip over if not restrained. The heater is to be held in that position and the tipping angle is to be measured.

**45 Tank-Securement Test**

45.1 A vacuum tank, when placed on the sump in the intended manner, shall not become dislodged from its position when a horizontal force of 25 pounds (111.2 N) is applied for 1 minute uniformly against any exposed surface of the tank when it is full or one-fourth full.

**46 Sump-Capacity Test**

46.1 A heater employing vacuum feed shall be constructed so that kerosene will not overflow the sump, with the fuel-regulating device closed, when a quantity of fuel equal to 6 percent of the capacity of the tank is added to the amount normally in the sump.

46.2 To determine compliance with the requirement in 46.1, a heater is to be leveled and the fuel-regulating device is to be closed. The tank is to be filled with kerosene at room temperature and placed in its intended position on the sump. When the fuel level has reached equilibrium in the sump, the additional quantity of kerosene is to be poured into the sump. No kerosene shall overflow at the sump.

46.3 A heater employing vacuum feed shall be constructed so that the level of kerosene will be at least 1/4 inch (6.4 mm) below the lowest point at which discharge could occur from the burner, with the fuel-regulating device open, when the fuel level in the sump is raised to the level where kerosene will overflow the sump.

46.4 To determine compliance with the requirement in 46.3, as a continuation of the test described in 46.2, the fuel-regulating device is to be opened and the levels of kerosene in the burner and sump allowed to reach equilibrium. Kerosene is then to be added to the sump until the level is reached in the sump at which overflow from the sump occurs.

**47 Normal Fuel-Level Test**

47.1 A heater shall be constructed so that when the heater is level, the minimum distance between the maximum intended kerosene level in the burner maintained by the primary safety control and the level of the lowest point at which overflow may occur is not less than 3/4 inch (19.1 mm).

47.2 The heater is to be leveled and the burner metering arrangement is to be adjusted for maximum input. Measurements are to be taken after equilibrium conditions of fuel levels have been attained.

## 48 Temperature Test

### 48.1 General

48.1.1 A heater shall be tested as specified in 48.2.1 – 48.6.2 and no part shall attain a temperature sufficient to:

a) Damage required corrosion protection,

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b) Impair the operation of safety controls,

c) Impair the value of required thermal or electrical insulation, or

d) Cause creeping, distortion, sagging or similar damage.

The temperature rises at specific points shall not be greater than those specified in Table 48.1 unless otherwise indicated.

**48.2 Room heater**

48.2.1 The heater shall be tested in accordance with 48.4.1.1 – 48.5.5 and the cheesecloth shall not ignite or produce glowing particles. The maximum temperature rise on heater components shall not exceed the values specified for such items in Column 1 of Table 48.1.

**48.3 Portable heater**

48.3.1 A portable heater shall be fired at any input allowed by the regulating device and tested in accordance with 48.4.1.1, 48.4.1.2, 48.6.1, 48.6.2 and 48.6.3. The cheesecloth applied to the vertical wall and the wall itself shall not ignite or produce glowing particles. The maximum temperature rise on heater components shall not exceed the values specified for such items in Column 1 of Table 48.1.

## Table 48.1
## Maximum temperature rises[a,f]

Table 48.1 revised January 26, 2000

| Device or material | | Column 1 Degrees C | Column 1 Degrees F | Column 2 Degrees C | Column 2 Degrees F |
|---|---|---|---|---|---|
| A. | COMPONENTS | | | | |
| | 1. Fuses | 65 | 117 | 90 | 162 |
| | 2. Relay and solenoid coil windings with: | | | | |
| | a. Class 105 insulated winding | | | | |
| | Thermocouple method | 65 | 117 | 115 | 208 |
| | Resistance method | 85 | 153 | 115 | 208 |
| | b. Class 130 insulated winding | | | | |
| | Thermocouple method | 85 | 153 | 140 | 252 |
| | Resistance method | 95 | 171 | 140 | 252 |
| | 3. Sealing compounds | Maximum temperature 15°C (27°F) less than melting temperature | | | |
| B. | INSULATED CONDUCTORS | | | | |
| | 1. Appliance wiring material[d] | | | | |
| | 75°C rating | 50 | 90 | – | – |
| | 80°C rating | 55 | 99 | 70 | 126 |
| | 90°C rating | 65 | 117 | 80 | 144 |
| | 105°C rating | 80 | 144 | 95 | 171 |
| | 200°C rating | 175 | 315 | 200 | 360 |
| | 250°C rating | 225 | 405 | 250 | 450 |
| | 2. Flexible cords – Types SJ, SJO, SJT, SJTO, including surfaces of the appliance which the cord may contact | 35 | 63 | 60 | 108 |
| | 3. Other types of insulated wires | e | | | |
| | 4. Wire, code[d] | | | | |
| | Type RUW | 35 | 63 | 60 | 108 |
| | Types RH, RFH, FFH, RHW, THW, THWN | 50 | 90 | 75 | 135 |
| | Types TF, TFF, TW | 35 | 63 | 60 | 108 |
| | Type TA | 65 | 117 | 90 | 162 |
| C. | ELECTRICAL INSULATION | | | | |
| | 1. Fiber used as electrical insulation | 65 | 117 | 90 | 162 |
| | 2. Phenolic composition used as electrical insulation or parts the deterioration of which may result in a risk of fire or electric shock[d] | 125 | 225 | 150 | 270 |
| D. | METALS | | | | |
| | 1. Aluminum alloys | | | | |
| | 1100 | 183 | 329 | 239 | 430 |
| | 3033 | 239 | 430 | 294 | 529 |
| | 2014, 2017, 2024, 5052 | 294 | 529 | 350 | 630 |
| | 2. Aluminum-coated steel[b] | 656 | 1181 | 767 | 1381 |
| | 3. Carbon steel coated with Type A19 ceramic | 572 | 1030 | 683 | 1229 |
| | 4. Carbon steel sheet, cast iron | 517 | 931 | 683 | 1229 |
| | 5. Galvanized steel[c] | 267 | 481 | 350 | 630 |
| | 6. Stainless steel | | | | |
| | Types 302, 303, 304, 316, 321, 347 | 767 | 1381 | 878 | 1580 |
| | Type 309 | 961 | 1730 | 1072 | 1930 |
| | Type 310 | 1017 | 1831 | 1128 | 2030 |
| | Type 405 | 683 | 1229 | 795 | 1431 |



Table 48.1 Continued on Next Page

## Table 48.1 Continued

| Device or material | Column 1 Degrees C | Column 1 Degrees F | Column 2 Degrees C | Column 2 Degrees F |
|---|---|---|---|---|
| Types 403, 409, 410, 416 | 572 | 1030 | 683 | 1229 |
| Type 430 | 711 | 1280 | 822 | 1480 |
| Type 442 | 877 | 1579 | 933 | 1679 |
| Type 446 | 961 | 1730 | 1072 | 1930 |
| E. GENERAL | | | | |
| 1. Fuel lines | | | | |
| a. Aluminum tubing | 346 | 623 | 457 | 823 |
| b. Copper tubing | 207 | 373 | 318 | 572 |
| c. Steel tubing | 402 | 724 | 513 | 923 |
| 2. Oil in constant-level valve, sump, or tank | See Section 47 | | | |
| 3. Surfaces of test enclosure floor and appliance surfaces in contact with floor | 50 | 90 | 97 | 175 |
| 4. Surfaces of test enclosure (ceiling, walls, and the like) | 50 | 90 | 97 | 175 |
| 5. Surfaces of appliance at points of zero clearance to test structure | 50 | 90 | 97 | 175 |
| F. HANDLES, KNOBS, AND THE LIKE[g] | 95 | 171 | 140 | 252 |
| 1. Metallic | 33 | 60 | – | – |
| 2. Plastic | 44 | 80 | – | – |
| G. MOTOR INSULATION SYSTEMS | | | | |
| 1. Coil windings of alternating-current motors having a frame diameter[h] of 7 inches (178 mm) or less (not including universal motors)[i] | 50 | 90 | – | – |
| Class A Insulation | | | | |
| a. In open motors – | | | | |
| Thermocouple or resistance method | 75 | 135 | 115 | 208 |
| b. In totally enclosured motors – | | | | |
| Thermocouple or resistance method | 80 | 144 | 115 | 208 |
| Class B Insulation | | | | |
| a. In open motors – | | | | |
| Thermocouple or resistance method | 95 | 171 | 140 | 252 |
| b. In totally enclosured motors – | | | | |
| Thermocouple or resistance method | 100 | 180 | 140 | 252 |
| 2. Coil windings of alternating-current motors having a frame diameter[h] of more than 7 inches (178 mm) and of direct-current motors and universal motors[i] | | | | |
| Class A insulation | | | | |
| a. In open motors – | | | | |
| Thermocouple method | 65 | 117 | 115 | 208 |
| Resistance method | 75 | 135 | 115 | 208 |
| b. In totally enclosured motors – | | | | |
| Thermocouple method | 70 | 126 | 115 | 208 |
| Resistance method | 80 | 144 | 115 | 208 |
| Class B Insulation | | | | |
| a. In open motors – | | | | |
| Thermocouple method | 85 | 153 | 140 | 252 |
| Resistance method | 95 | 171 | 140 | 252 |
| b. In totally enclosured motors – | | | | |
| Thermocouple method | 90 | 162 | 140 | 252 |



Table 48.1 Continued on Next Page

## Table 48.1 Continued

| Device or material | Column 1 | | Column 2 | |
|---|---|---|---|---|
| | Degrees | | Degrees | |
| | C | F | C | F |
| Resistance method | 100 | 180 | 140 | 252 |

[a] The specified maximum temperature rises apply to parts of an appliance, the malfunction of which may cause a risk of fire, electric shock, or injury to persons.

[b] When the reflectivity of an aluminum-coating is utilized to reduce temperature, the maximum allowable temperature rise is 461°C (830°F).

[c] The specified maximum temperature rises apply if galvanizing is required as a protective coating or the reflectivity of the surface is utilized to reduce temperatures.

[d] The limitations on rubber and thermoplastic insulation and on phenolic composition do not apply to compounds that have been investigated and found acceptable for higher temperatures than those specified in Table 48.1.

[e] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code, ANSI/NFPA 70-1999. The maximum allowable temperature rise in any case is 25°C (45°F) less than the temperature limit of the wire in question where Column 1 temperature rises are specified, and the maximum allowable temperature rise where Column 2 rises are specified is to be based on the heat resistant properties of the insulation.

[f] The inclusion of a temperature limit for a material in this table is not indicative of the acceptability of the material if it does not otherwise conform to these requirements.

[g] This applies to handles, knobs, buttons, and the like, that are likely to be contacted by the user during intended operation of the heater or while the heater is still hot.

[h] The motor frame diameter is to be measured in the plane of the laminations of the circle circumscribing the stator frame, excluding lugs, boxes, or the like, used solely for motor cooling, mounting, assembly, or connection.



Table 48.1 Continued on Next Page

**Table 48.1 Continued**

| Device or material | Column 1 | | Column 2 | |
|---|---|---|---|---|
| | Degrees | | Degrees | |
| | C | F | C | F |
| [i] Coil or winding temperature are to be measured by thermocouples unless the coil is inaccessible for attachment devices (such as a coil immersed in sealing compound) or unless the coil wrap includes thermal insulation or more than two layers, 1/32 inch (0.8 mm) maximum, of cotton, paper, rayon, or the like. For a thermocouple measured temperature of a coil of an alternating-current motor, other than a universal motor, having a diameter of 7 inches (178 mm) or less, the thermocouple is to be attached on the integrally applied insulation on the conductor. At a point on the surface of a coil (not including universal motors) where the temperature is affected by an external source of heat, the Column 1 temperature rise as measured by a thermocouple may exceed the indicated maximum by the amounts specified in items 1 – 4, provided that the temperature rise of the coil as measured by the resistance method is not more than specified in the table.<br><br>1. 5°C (9°F) for Class A insulation on coil windings of open-type alternating-current motors having a diameter of 7 inches (178 mm) or less. (See subitem 1 of (g));<br><br>2. 10°C (18°F) for a Class B insulation on coil windings of open-type alternating-current motors having a diameter of 7 inches or less. (See subitem 1 of (g));<br><br>3. 15°C (27°F) for Class A insulation on coil windings of open-type alternating-current motors having a diameter of more than 7 inches. (See subitem 2 of (g));<br><br>4. 20°C (36°F) for Class B insulation on coil windings of open-type alternating-current motors having a diameter of more than 7 inches. (See subitem 2 of (g)). | | | | |

48.3.2 When a portable heater is tested as described in 48.6.5, the cheesecloth draped over the heater shall not ignite.

## 48.4 Test method

48.4.1 General

48.4.1.1 The heater is to be leveled. If the leveling means is detachable, it is to be removed; if not detachable, it is to be adjusted to place the base of the heater the minimum allowable distance above the floor.

48.4.1.2 The fuel-regulating device shall be capable of delivering the maximum input specified by the manufacturer at the maximum allowable setting.

## 48.5 Room heater

48.5.1 A room heater is to be tested in a partial enclosure as illustrated in Figure 40.1. The distance from the side and back of the heater is to be the minimum recommended by the manufacturer, but the distances from the heater to the walls are not to exceed 18 inches (0.46 m). If one side of a heater creates higher wall temperatures than the other, then that side of the heater is to be located away from the wall. If the casing is provided with adjustable doors or louvers, then such doors or louvers are to be placed in the position allowing maximum temperature conditions.

48.5.2 Two layers of cheesecloth are to be loosely draped over the top and all outlets of circulating-type room heater casing.

48.5.3 The heater is to be fired at the maximum input allowed by the fuel-regulating device. Firing is to be continuous until equilibrium temperatures are attained.

48.5.4 The heater is then to be fired at an input equivalent to one-fourth of the high-fire input rate until equilibrium or continually receding temperatures are attained.

48.5.5 If a heater is equipped with an air-circulating fan, the tests in 48.5.1 – 48.5.4 are to be conducted with the fan idle until equilibrium temperatures are attained and are then to be continued with the fan operating until equilibrium or continually receding temperatures are attained.

## 48.6 Portable heater

48.6.1 A portable heater is to be tested in a partial enclosure as illustrated in Figure 40.1. The heater is to be placed at the midpoint of one wall as close to the wall as the legs or other parts of the heater will permit and is to be subjected to wall-ignition and component-temperature tests in accordance with 48.6.2 and 48.6.3.

48.6.2 For the wall-ignition test, the side of the heater that radiates the most heat is to be placed facing the wall. A layer of cheesecloth is to be applied to the wall by tacking it into place as a wall covering. The heater is to be operated continuously for the period required to consume one full tank of kerosene, except that the test may be discontinued after 7 hours if equilibrium conditions have been reached. The fuel-regulating control is to be set at the maximum allowable setting.

48.6.3 For the component-temperature test, a directional heater is to be placed so that the side of the heater that radiates the most heat faces away from the wall. An omnidirectional heater is to be placed so that the fuel-regulating control faces away from the wall. The fuel-regulating control is to be set at the maximum allowable setting. The heater is to be operated continuously until equilibrium temperatures are attained.

48.6.4 The test described in 48.6.3 is to be repeated at the minimum burner setting allowed by the wick stop of the wick-adjusting mechanism. See 14.3.

48.6.5 Under the test conditions described in 48.6.3 and with the heater operating at the maximum allowable burner setting, two layers of cheesecloth are to be draped over the heater for 30 seconds. The cheesecloth is to be draped over the top and sides of the heater so that it:

a) Reaches the floor on the sides of the heater, and

b) is oriented to cover the surface of the heater that radiates the most heat. The cheesecloth used for the test is to be that described in 38.6. A heater with an air-circulating fan in which the burner can operate with the fan idle is to be tested with:

1) The fan operating, and

2) The fan idle.

## 49 Kerosene-Temperature Test

49.1 A heater shall be tested in accordance with 49.2 and the temperature rise of kerosene in the tank of the heater shall not exceed 25°F (13.9°C) above the room ambient.

*Exception: For a portable omnidirectional heater (a round heater that radiates heat uniformly in all directions in a horizontal plane) that is marked with the minimum clearance to combustible materials at which it can be operated, the temperature rise of kerosene may be not more than 30°F (16.7°C) above the room ambient when it is tested in accordance with 49.2 and 49.3.*

49.2 The test procedures for different types of heaters follows:

a) A room heater is to be tested in accordance with 48.5.1 – 48.5.5, except that cheesecloth is not to be draped over the top and air outlets of a circulating-type heater.

b) Directional and omnidirectional portable heaters are to be tested in accordance with 48.4.1.1, 48.4.1.2, 48.6.1, 48.6.3, and 48.6.4.

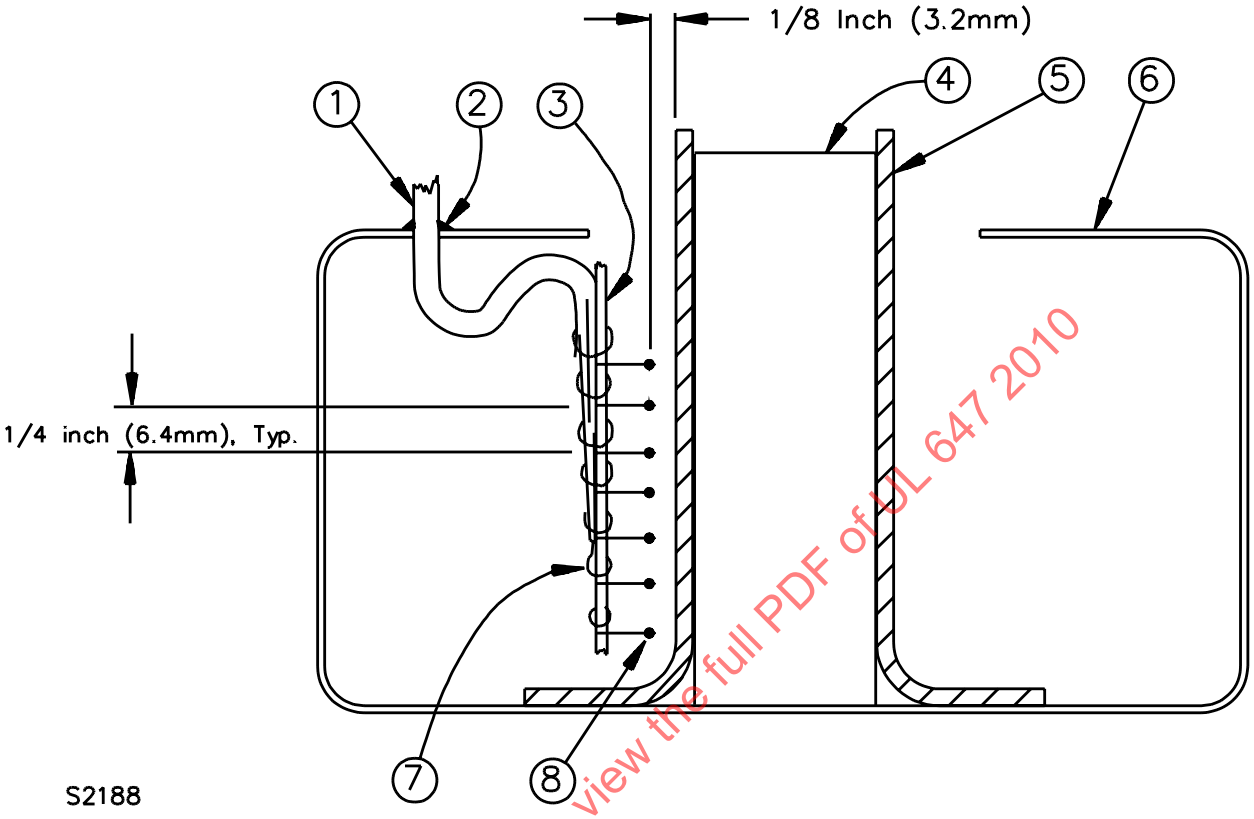
c) For an omnidirectional portable heater, if the temperature of the kerosene exceeds the room temperature by more than 25°F (13.9°C) but not more than 30°F (16.7°C), the heater may be tested away from the wall at the minimum clearance marked on the heater.

49.2 revised January 26, 2000

49.3 The kerosene temperature is to be measured with the thermocouple grid illustrated in Figure 49.1, except for a heater equipped with a vacuum-feed tank, in which case thermocouples are to be placed on the sides of the tank. When maximum equilibrium temperatures are observed, the tank is to be removed from the heater and inverted. The temperature of the kerosene is to be measured with a thermocouple through the fill opening. During the measurement of the kerosene temperature the tip of the thermocouple is not to contact the tank surface.

**Figure 49.1**
**Thermocouple grid for measuring kerosene temperatures for wick-type heaters**

Figure 49.1 revised April 16, 2010






Cutaway view of typical grid installation where:

1 = Thermocouple cable.

2 = Seal.

3 = Thermocouple support – 14 AWG (2.08 $mm^2$) copper wire. Length may be adjusted to provide support as required.

4 = Primary air tube.

5 = Wick.

6 = Fuel reservoir.

7 = Thermocouples tied and epoxied to thermocouple support.

8 = Thermocouple bead.

NOTE – Height of grid may be varied depending on fuel reservoir geometry.

49.4 The measurement of kerosene temperature is to be made starting with a full tank of kerosene and monitoring the temperatures at various levels for the time period required to consume the full tank of kerosene. The test can be discontinued earlier if continually decreasing temperatures are observed.

49.5 The temperature limits for kerosene in the tank also apply to kerosene in the sump unless the construction of the heater is such that all kerosene vapors from the sump can vent only through the burner. The temperature of the kerosene in the sump shall be determined by a thermocouple grid, as described in 49.2 and 49.4.

## 50 Lighting Test

50.1 A heater, when lighted as described in 50.2 and 50.3, shall cause no flash or puff.

50.2 The initial conditions for test are to be as described in 43.3.

50.3 In 50.4– 50.14, the test methods described pertain to vaporizing-type burners in which the burner operation is initiated by turning on the fuel by a fuel-regulating device and igniting the fuel manually by a torch or a taper. The burner operation is terminated by shutting off the fuel by the fuel-regulating device. The fuel-regulating device is used to control the firing rate of the burner. The tests specified in this section and the basic methods are also applicable to heaters employing wick-type burners except for the following changes in the test methods:

a) For a wick-type burner, the burner operation is initiated by raising the wick and then energizing an igniter or using a match to light the burner.

b) The burner firing rate is controlled by adjusting the wick height.

c) The burner is turned off by lowering the wick.

50.4 With the heater at room temperature, the burners are to be lighted in accordance with the manufacturer's instructions. After ignition is obtained, the fuel-regulating device is to be set to fire the burner at high-fire input for at least 15 minutes. The fuel is then to be shut off and, immediately following extinguishment of a burner flame, the burner is to be again lighted by first introducing a torch or taper into the burner and then turning on the fuel.

50.5 A heater employing a wick burner shall be constructed so that stable ignition is obtained within 5 minutes when the burner is lighted in accordance with the instructions furnished with the heater and in accordance with 50.6 and 50.7.

50.6 The initial conditions for test are to be as described in 43.3.

50.7 The burner is to be lighted in accordance with the instructions and allowed to fire at high-fire input for at least 15 minutes. The fuel is then to be turned off. After the heater has attained room temperature, the burner is to be again lighted in accordance with the instructions. The interval from the time the fuel-regulating device is opened until stable ignition can be obtained is to be not more than 5 minutes.