

UL 733

ISBN 1-55989-457-1

Oil-Fired Air Heaters and Direct-Fired Heaters

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Oil-Fired Air Heaters and Direct-Fired Heaters, UL 733

Fourth Edition, Dated August 25, 1993

Revisions: This Standard contains revisions through and including December 13, 2005.

Summary of Topics

The revisions to UL 733 include the following changes in requirements:

- 1. Scope Paragraph Addressing New or Unusual Constructions***
- 2. Undated References***
- 3. Reference to ASTM A525***
- 4. Removal of Reference to UL 214***
- 5. Identification of Neutral Conductor***
- 6. Identification of Equipment Grounding Conductor***
- 7. Standards for Components***
- 8. Wire Size Designation, Removal of Date References to the National Electrical Code, ANSI/NFPA 70, and Typographical Correction.***

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due to relocation of existing text and reformatting of the Standard.

Text that has been changed in any manner 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.

The following table lists the future effective dates with the corresponding reference.

Future Effective Dates	References
June 13, 2007	Paragraphs 21.2.7, 24.18 and Figure 24.1.

The new and revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated March 25, 2005.

The revisions dated December 13, 2005 include a reprinted title page (page1) for this Standard.

The revisions dated January 20, 1999 were issued to change references to UL 547, Standard for Thermal Protectors for Motors, to the Standard for Overheating Protection for Motors, UL 2111. UL 547 has been withdrawn and replaced by UL 2111. These revisions were also issued to remove the "94" prefix from the flammability classifications. This type of flame classification has become familiar globally, therefore there is no need to retain the "94" designation.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net.ul.com/ulforeword.html>

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

UL's Standards for Safety are copyrighted by UL. Neither a printed copy of a Standard, nor the distribution diskette for a Standard-on-Diskette and the file for the Standard on the distribution diskette should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

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.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

Copyright © 2005 Underwriters Laboratories Inc.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-6B	December 13, 2005
7-12	August 25, 1993
13	December 13, 2005
14	August 25, 1993
15	January 20, 1999
16-24	December 13, 2005
25-26	August 25, 1993
27-30B	December 13, 2005
31-35	August 25, 1993
36-38	December 13, 2005
39	August 25, 1993
40-41	January 20, 1999
42-48	August 25, 1993
48A-49	December 13, 2005
50	January 20, 1999
51-52	December 13, 2005
53-63	August 25, 1993
64	December 13, 2005
65-73	August 25, 1993
74-75	December 13, 2005
76-82	August 25, 1993
83-84	January 29, 1996
A1-A2	December 13, 2005
SR1-SR2	December 13, 2005

AUGUST 25, 1993

(Title Page Reprinted: December 13, 2005)

1

UL 733

Standard for Oil-Fired Air Heaters and Direct-Fired Heaters

First Edition – August, 1955

Second Edition – May, 1973

Third Edition – July, 1975

Fourth Edition

August 25, 1993

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

ISBN 1-55989-457-1

COPYRIGHT © 1975, 2005 UNDERWRITERS LABORATORIES INC.

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope	5
2 General	5
3 Units of Measurement	6
3A Undated References	6
4 Glossary	6
5 Instructions	9

CONSTRUCTION

6 Assembly	10
7 Accessibility for Servicing	11
8 Disposal of Combustion Products	11
9 Casing	12
10 Radiation Shields or Liners and Materials in Air Handling Compartments	12
11 Air Filter	13
12 Integral Oil Tanks	13
13 Combustion Chamber	14
14 Radiator	14
15 Heating Surface Joints	14
16 Baffles	15
17 Flue Collar	15
18 Damper and Draft Regulator	16
19 Ducts	16
20 Controls	16
20.1 Application	16
20.2 Limit control	16A
20.3 Primary safety control	16A
21 Field Wiring	16B
21.1 General	16B
21.2 Leads and terminals	18
22 Internal Wiring	19
22.1 General	19
22.2 Methods	20
22.3 Short circuit protection	23
23 Separation of Circuits	23
24 Bonding for Grounding	25

ELECTRICAL COMPONENTS

25 General	28
26 Mounting of Electrical Components	29
27 Electrical Enclosures	29
27.1 General	29
27.2 Doors and covers	34
27.3 Field wiring system connection	35
28 Motors and Motor Overload Protection	36
29 Switches and Controllers	41
30 Capacitors	41

31 Insulating Material	42
------------------------------	----

SPACINGS

32 High-Voltage Circuits	42
33 Low-Voltage Circuits	44

PROTECTION OF USERS AND SERVICE PERSONNEL

34 General	44
------------------	----

PERFORMANCE

35 General	47
36 Test Installation	48
37 Instrumentation	48A
37.1 Draft	48A
37.2 Fuel input	48B
37.3 Power measurement	48B
37.4 Speed measurement	48B
37.5 Static pressure	51
37.6 Temperature measurement	51
38 Initial Test Conditions	53
38.1 General	53
38.2 Heater equipped with mechanical atomizing burner	54
38.3 Heater equipped with vaporizing burner	54
39 Combustion Test – Burner and Heater	55
40 Operation Tests	55
41 Limit Control Cutout Test	55
42 Continuity of Operation Test	56
43 Temperature Tests	56
44 Continuous Operation Temperature Test	60
45 Blocked Inlet Test	61
46 Fan Failure Test	61
47 Stalled Fan Motor Test	62
48 Blocked Outlet Test	62
49 Maximum Wall Temperature Test	62
50 Short Circuit Test	63
51 Dielectric Withstand Test	66
52 Leakage Current Test	66

MANUFACTURING AND PRODUCTION TESTS

53 General	69
54 Production Line Dielectric Withstand Test	70
55 Production Line Grounding Continuity Test	70

MARKING

56 General	71
------------------	----

CONSTRUCTION – OUTDOOR USE EQUIPMENT

57 General	73
58 Enclosure	73
58.1 General	73
58.2 Corrosion protection	74
59 Wiring	76

PERFORMANCE – OUTDOOR USE EQUIPMENT

60 Rain Test	76
61 Chromic Acid Dropping Test	80
62 Gaskets	81

MARKING – OUTDOOR USE EQUIPMENT

63 General	83
------------------	----

APPENDIX A

Standards for Component	A1
-------------------------------	----

This page intentionally left blank.

INTRODUCTION

1 Scope

1.1 These requirements apply to oil-fired air heaters and direct-fired heaters.

1.2 Requirements for the installation and use of oil-burning equipment are included in the Standard for the Installation of Oil-Burning Equipment, NFPA 31.

1.3 *Deleted December 13, 2005*

2 General

2.1 The term "appliance" refers to any equipment covered by this Standard.

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

2.3 Except as indicated in 2.4, 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 generally used in the products covered by this standard.

2.4 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.

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

2.6 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.

3 Units of Measurement

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

3A Undated References

3A.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3A.1 added December 13, 2005

4 Glossary

4.1 For the purpose of this Standard the following definitions apply.

4.2 AIR HEATER – An indirect-fired vented appliance intended to supply heated air for space heating and other purposes, but not intended for permanent installation. This definition does not include central furnaces, kerosene stoves, oil-burning stoves, or unit heaters.

4.3 AIR SHUTTER – An adjustable device for varying the size of the air inlet or inlets regulating primary and/or secondary air.

4.4 ANTIFLOODING DEVICE – A primary safety control which causes the fuel flow to be shut off upon a rise in fuel level or upon receiving excess fuel, and which operates before the hazardous discharge of fuel can occur.

4.5 APPLIANCE FLUE – The flue passages with in the appliance.

4.6 AUTOMATICALLY LIGHTED APPLIANCE – An appliance in which fuel to the main burner is normally turned on and ignited automatically.

4.7 BAFFLE – An object placed in an appliance to direct the flow of air or flue gases.

4.8 BURNER, MECHANICAL-ATOMIZING TYPE – A power-operated burner which prepares and delivers the oil and all or part of the air by mechanical process in controllable quantities for combustion. Some examples are air atomizing, high and low pressure atomizing, horizontal rotary, vertical rotary atomizing, and vertical rotary wall-flame burners.

4.9 BURNER, MECHANICAL DRAFT TYPE – A burner which includes a power-drive fan, blower, or other mechanism as the principal means for supplying air for combustion.

4.10 BURNER, NATURAL DRAFT TYPE – A burner which depends principally upon the natural draft created in the flue to induce into the burner the air required for combustion.

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

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

4.13 CENTRAL HEATING APPLIANCE – A stationary indirect-fired vented appliance comprising the following classes: boilers, central furnaces, floor furnaces, and recessed heaters. A floor-mounted unit heater to be connected to a duct system is categorized also as a central heating appliance.

4.14 COMBUSTIBLE MATERIAL – Combustible material as pertaining to materials adjacent to or in contact with heat-producing appliances, chimney connectors and vent connectors, steam and hot-water pipes, and warm-air ducts means material made of or surfaced with 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.

4.15 COMBUSTION CHAMBER – The portion of an appliance within which combustion occurs.

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

No Text on This Page

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

4.18 CONTROL, SAFETY – Automatic controls, including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety control system, which are intended to prevent unsafe operation of the controlled equipment.

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

4.20 CONTROL, SAFETY COMBUSTION – A primary safety control responsive directly to flame properties; sensing the presence of flame and causing fuel to be shut off in event of flame failure.

4.21 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 the appliance or in the chimney connector.

4.22 DAMPER, AUTOMATICALLY OPERATED – A damper operated by an automatic control.

4.23 DAMPER, MANUALLY OPERATED – An adjustable damper manually set and locked in the desired position.

4.24 DIRECT-FIRED HEATER – A heater in which combustion products or flue gases are mixed with the air being heated, such as a salamander.

4.25 DRAFT REGULATOR – A device which functions to maintain a desired draft in the appliance by automatically reducing the chimney draft to the desired value.

4.26 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 (42.4 peak) or direct current and supplied by:

1) A Class 2 transformer, or by a battery, by a battery and fixed impedance, or by transformer and fixed impedance, each of which, as a unit is in compliance with what is required for a Class 2 transformer; or

2) Is limited to a maximum of 100 volt-amperes. 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) Safety Control Circuit – A circuit involving one or more safety controls.

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

4.28 FLUE – A general term for the conduit or passageway through which flue gases pass from the combustion chamber to the outside air.

4.29 FLUE COLLAR – That portion of an appliance intended for attachment of the chimney or vent connector.

4.30 FLUE GASES – Combustion products and excess air.

4.31 FUEL OIL – Any hydrocarbon oil as defined by Commercial Standard CS12 or ASTM D396-1969, ANSI Z11.203-1970.

4.32 HEAT EXCHANGER, DIRECT – A heat exchanger in which heat generated in the combustion chamber of the appliance is transferred direct through walls of the appliance to the heating medium (such as air, stream, or water) held in close contact with the combustion chamber walls. It is a self-contained combustion and heat exchanger.

4.33 HEAT EXCHANGER, INDIRECT – A heat exchanger which encloses or contains a heating medium, such as air, steam, or water, the heat from which is transferred to another heating medium separately contained in close contact with or directed through the heat exchanger.

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

4.35 INDIRECT-FIRED APPLIANCE – An appliance designed so that combustion products or flue gases are not mixed in the appliance with the medium to be heated and provided with a flue collar.

4.36 MANUALLY LIGHTED APPLIANCE – An appliance in which fuel to the main burner is turned on only by hand and ignited under supervision.

4.37 NORMAL CARE – The periodic tasks usually performed to operate and maintain an appliance, such as air, fuel, pressure, and temperature regulation, cleaning, lubrication, resetting of controls, etc. Repair and replacement of parts other than those expected to be renewed periodically is not considered to be normal care. Some examples of normal care are:

- a) Cleaning or replacing nozzles, atomizers, and pilots.
- b) Setting ignition electrodes.
- c) Cleaning strainers or replacing strainer or filter elements.
- d) Resetting safety control.
- e) Replacing igniter cable.

4.38 OIL-BURNING DIRECT-FIRED HEATER – A direct-fired heater as defined herein equipped with one or more oil burners, safety controls, electrical equipment as needed, and related equipment, manufactured for assembly as a complete unit.

4.39 OIL-FIRED AIR HEATER – An air heater equipped with one or more oil burners, safety controls, electrical equipment as needed, and related equipment, manufactured for assembly as a complete unit.

4.40 PILOT – A flame, smaller than the main flame, which is utilized to ignite the fuel at the main burner(s).

4.41 **PORTABLE APPLIANCE** – A mobile appliance or one intended to be moved from place to place. The term indicates a temporary installation as opposed to a permanent installation.

4.42 **PRIMARY AIR** – The air introduced into a burner and which mixes with the fuel before it reaches the ignition zone.

4.43 **RADIATION SHIELD OR LINER** – A separate panel(s) interposed between heating surfaces and adjacent objects to reduce heat transmission by radiation.

4.44 **RADIATOR** – Auxiliary heat transfer surfaces within the casing, connected between the combustion chamber and the flue collar.

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

4.46 **SECONDARY AIR** – The air externally supplied to the flame at or beyond the point of ignition.

4.47 **SPECIAL PARTS AND TOOLS** – Those parts and tools that are not available on the open retail market.

4.48 **THERMOSTAT** – An automatic control actuated by temperature change to maintain temperatures between predetermined limits.

4.49 **VALVE, MANUAL OIL SHUTOFF** – A manually operated valve in the oil line for the purpose of completely turning on or shutting off the oil supply to the burner.

4.50 **VALVE, OIL CONTROL** – An automatically or manually operated device consisting essentially of an oil valve for controlling the fuel supply to a burner.

a) **Metering (Regulating) Valve** – An oil 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 safety control or by an emergency device.

4.51 **VENTED APPLIANCE** – An indirect-fired appliance provided with a flue collar to accommodate a flue pipe for conveying flue gases to the outer air.

5 Instructions

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

5.2 The instructions should include such directions and information as deemed by the manufacturer to be adequate for attaining proper and safe installation, maintenance, and use of the heater.

CONSTRUCTION

6 Assembly

6.1 A heater shall be factory-built as a group assembly and shall include all the essential components necessary for its normal function when installed as intended. An oil-fired heater may be shipped as two or more major subassemblies.

6.2 A direct-fired heater and an outdoor-use air heater shall conform also to Sections 57 – 63.

6.3 The various parts of an oil-fired heater shall be constructed and assembled in accordance with these requirements in a manner to ensure strength, rigidity, and durability.

6.4 A heater, if not assembled by the manufacturer as a unit, shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated readily into the final assembly without requiring alteration, cutting, drilling (except to the extent indicated in 6.5) threading, welding, or similar tasks by the installer. Two or more subassemblies, which must bear a definite relationship to each other for the proper and safe installation or operation of the heater shall be arranged and constructed to permit them to be incorporated into the complete assembly, only in the correct relationship with each other; without need for alternation or alignment; or such subassemblies shall be assembled, tested, and shipped from the factory as one element.

6.5 To be in accordance with 6.4 major subassemblies of a heater are deemed to be the burner; the heat exchanger, including its base, combustion chamber, casing, and safety controls; the blower assembly, including the base, filters, and casing; and the blower motor if not included as part of the blower assembly. A wiring harness may be packaged with one of the major subassemblies.

6.6 The base, frame, or housing of a heater shall be constructed to permit movement of the heater without damaging it. Parts of the heater shall not be damaged when any side of the heater is placed as close to a solid vertical wall as the base, frame, or housing will permit.

6.7 The chassis or frame of a mobile heater intended to be hauled by a vehicle shall be constructed of channel-iron framework or of formed-steel members not less than 0.134 inch (3.40 mm), or the equivalent, adequately cross-braced, and of sufficient strength to support safely, with a factor of not less than five, the framework and equipment when in transit. The hitching yoke which extends in front of the assembly and to which the coupling mechanism is attached shall be an integral part of the chassis.

6.8 The chassis should be equipped with springs, wheels, and brakes of a strength and construction to ensure safety while the heater is in transit.

6.9 A radiation shield or baffle employed to prevent excessive temperature shall be assembled as part of the heater; or be part of a subassembly that must be attached to the heater for its normal operation; or be such that the heater cannot be assembled for operation without first attaching a required shield or baffle in its proper position.

6.10 An oil-fired heater shall afford convenient operation by the user of those parts requiring attention or manipulation in intended usage.

6.11 Parts, when adjustable or movable, shall be provided with locking devices to reduce the risk of unintentional shifting.

6.12 Screws or bolts used to attach parts that are detached for intended care or servicing of the appliance shall be capable of holding upon the application of the torques indicated in Table 6.1 after removal and replacement.

Table 6.1
Maximum torque requirements for screws

Screw size (mm)		Torque,	
		pound-inches	(N·m)
No. 8	(4.2)	20	(2.3)
No. 10	(4.8)	25	(2.8)
1/4 inch	(6.4)	100	(11.3)
5/16 inch	(7.9)	200	(22.6)
3/8 inch	(9.5)	350	(39.5)
7/16 inch	(11.1)	550	(62.1)
1/2 inch	(12.7)	800	(90.3)
9/16 inch	(14.3)	1200	(135.5)

6.13 Any external door providing access into the combustion chamber of a heater shall be self-closing.

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

6.15 A heater equipped with an antiflooding device shall be constructed so that, when the heater is level, the minimum distance between the intended maximum oil level maintained by the oil control device and the level of the lowest point at which overflow may occur is not less than 3/4 inch (19.1 mm).

7 Accessibility for Servicing

7.1 A heater shall be built to allow cleaning of parts such as interior surfaces of vaporizing burners, heating surfaces in contact with combustion products, oil inlet pipes, and oil strainers, without major dismantling of the heater or removal of parts required by 6.3 to be factory-assembled.

7.2 The removal of access panels, burners, blowers, caps, plugs, and the like, specifically constructed to permit ready removal and replacement for servicing, and the detachment of the chimney connector are not considered major dismantling as defined by 7.1.

7.3 Accessibility shall be afforded for intended cleaning, inspection, repair, and replacement of all burners, operating controls, and safety controls. The disposition of parts in the assembly removed for intended care shall be such that their restoration following removal will not necessitate their realignment to secure their intended relationship with other parts of the assembly. Special tools or parts required for intended care to be done by the operator shall accompany the heater to the user.

8 Disposal of Combustion Products

8.1 The construction of a heater shall not allow the products of combustion to become mixed with the circulating air.

9 Casing

9.1 The outer casing or jacket shall be made of steel or equivalent material, reinforced or formed if necessary, so that it is not likely to be damaged through handling in shipment, installation, and use. Sheet metal casings shall be made of steel having a minimum thickness of 0.032 inch (0.81 mm) (No. 20 MSG).

9.2 Access panels needed to be removed for normal service and accessibility shall be constructed to permit removal and replacement repeatedly without causing damage or impairing any required insulating value.

9.3 A removable panel through which air is drawn for combustion shall be so constructed as to reduce the risk of its being attached in a manner that may result in a risk of fire, electric shock, or injury to persons.

9.4 A removable panel shall be so constructed that it will not be interchangeable with other panels on the same heater when interchange may result in a risk of fire, electric shock, or injury to persons.

9.5 The casing or base of a heater shall completely close the bottom or be constructed to provide an effective partition between the heat exchanger and the floor or ground.

9.6 Connection between the heat exchanger and the casing which encloses circulating air shall be constructed to reduce the risk of leakage of combustion products into the circulating air.

10 Radiation Shields or Liners and Materials in Air Handling Compartments

10.1 A radiation shield or liner shall be so constructed, formed, and supported so that it cannot be improperly positioned and so that distortion or sagging in service cannot occur. A shield or liner shall be protected against corrosion if its deterioration may cause temperatures in excess of those specified in Table 43.1 when the heater is tested in accordance with these requirements. Any finish intended to obtain the required resistance to corrosion shall not be damaged by heat when the heater is tested under these requirements.

10.2 Exposed unimpregnated asbestos material shall not be used in an air handling compartment. The unprotected edge of a gasket sandwiched between two parts is considered to be exposed.

10.3 Insulating material that is not self-supporting, employed as a radiation shield, shall be applied to solid surfaces in a manner to prevent sagging. The insulating material shall not have a flame spread rating over 25 nor a smoke developed rating over 50 when tested in accordance with the tests for surface burning characteristics of building materials, UL 723, and its insulating value shall be unimpaired by heat when the heater is tested under these requirements. An adhesive for attaching insulating material shall retain its adhesive qualities at any temperature it may attain when the heater is tested under these requirements and at 0°F (minus 17.8°C) or minus 20°F (minus 29°C) for outdoor use equipment.

10.4 Insulating material shall be securely positioned if:

- a) Loosening may reduce or block air flow to cause temperature or pressures in excess of those acceptable in the temperature tests, or
- b) Loosening will result in reduction of electrical spacings below the required values, short-circuiting, or grounding.

Leading edges of insulation shall be protected against damage from the effects of the velocity of the moving air.

10.5 A mechanical fastener for each square foot (m^2) of exposed surface is considered to securely position insulating liners. Mechanical fasteners may be bolts, metal clamps, wire rods, or the equivalent. Butting edges of insulation against bulkheads normally provides protection for leading edges against damage from effects of the velocity of moving air. Rigid or semirigid sheets of insulating material may not require fastening to the extent needed for less rigid material or protection of leading edges if the material possesses inherent resistance to damage.

11 Air Filter

11.1 A filter supplied as a part of the heater shall be accessible for inspection or replacement without the use of special tools and without dismantling the heater.

12 Integral Oil Tanks

12.1 A heater may be equipped with an integral oil supply tank having a capacity of not more than 20 gallons (76 liters) from which the fuel may be delivered to the burner by gravity or suction feed.

12.2 A tank shall be constructed of material equivalent to that described in 12.3 – 12.7.

12.3 Uncoated sheet steel shall have a minimum thickness of 0.053 inch (1.35 mm) (No. 16 MSG). A preservative shall be applied to uncoated surfaces of tanks to prevent rusting.

12.4 The thickness of aluminum-coated steel, galvanized sheet steel, terne sheet, and noncorrodible sheet metal shall be not less than that of No. 20 gage steel. Coated sheet shall be of prime finish, that is, free from blisters, flux, and uncoated spots visible to the unaided eye.

12.5 Galvanized steel shall have a coating of zinc conforming with the coating Designation G90 in Table I of ASTM Designation A653, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of zinc coating may be determined by any suitable method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM Designation A90-69.

12.5 revised December 13, 2005

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

12.7 The coating of aluminum-coated steel shall be adequate for the purpose as determined by test.

12.8 Tanks made of uncoated sheet steel, aluminum-coated steel, and terne sheet shall be of "full-drain" construction.

12.9 Full-drain construction is obtained by building a tank so that it is emptied through the fuel feed outlet at the bottom of the tank.

12.10 A tank not required to be full-drain construction shall allow the ready removal of any accumulation of water or sludge. For a tank not over 18 inches (457 mm) deep, this may be accomplished by providing an accessible fill opening large enough to permit entrance of the average adult hand.

12.11 Joints of all fuel tanks shall be lock-seamed (see 15.2), brazed, welded, or otherwise made mechanically secure. All joints not continuously brazed or welded shall be thoroughly sweated with solder. The brazing or welding of coated sheets less than 0.045 inch (1.14 mm) (No. 18 GSG) shall not damage the coating of the surfaces in contact with oil when the tank is full. All connections shall be made through solid threaded bosses or fittings mechanically secured to the tank.

12.12 A tank shall be constructed for permanent attachment to the heater and be supported securely in its proper position on the heater.

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

12.14 A gauge glass or sight feed, the breakage of which will allow the escape of fuel, shall not be used.

12.15 The top of the fill opening of a tank shall not be above the level at which oil will overflow the tank.

12.16 A tank shall permit filling by the operator from the floor level in a manner to avoid oil spillage without requiring the operator to reach over the heater.

12.17 A tank shall be equipped with a securely attached fill cap that is oil-tight when in place, except for the vent hole which shall be splash-proof.

13 Combustion Chamber

13.1 A combustion chamber shall be constructed of cast iron, sheet steel, or equivalent material. Sheet steel, if used, shall be such as to assure strength, rigidity, durability, resistance to corrosion, and other physical properties equivalent to sheet steel having a minimum thickness of 0.042 inch (1.07 mm) (No. 18 MSG).

13.2 For outdoor-use heaters, the combustion chamber shall be constructed of material equivalent to sheet steel having a minimum thickness of 0.053 inch (1.35 mm) (No. 16 MSG).

13.3 Combustion chamber or fire box lining material, if used, shall be durable, adequately held in place, and accessible for replacement with equivalent material.

14 Radiator

14.1 A radiator shall be made of material not lighter than that designated in 13.1 for a combustion chamber and shall be readily cleanable.

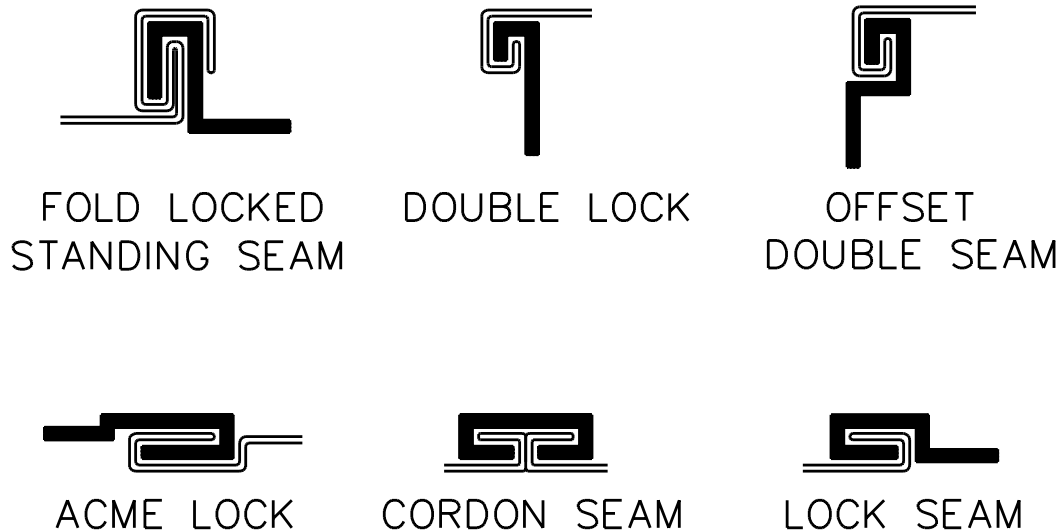
15 Heating Surface Joints

15.1 Joints in heating surfaces shall be substantial and reasonably tight, as attained by being welded, lock-seamed, machined and bolted, riveted, etc. A joint shall not depend primarily on cement for tightness. A slip or lap joint shall not depend solely upon friction of the joint itself for strength.

15.2 Examples of some acceptable lock-seams are illustrated by Figure 15.1.

Figure 15.1
Types of acceptable lock-seams

Figure 15.1 revised January 20, 1999



ED100

16 Baffles

16.1 A baffle in a flue-gas passage or otherwise exposed to combustion products shall be constructed and disposed in a manner to provide for reasonable life and shall be fixed in position. A flue baffle shall be made of material having resistance to corrosion equivalent to AISI C1010 hot-rolled sheet steel having a minimum thickness of 0.042 inch (1.07 mm) (No. 18 MSG) unless its deterioration will not cause excessive temperatures when the heater is tested in accordance with these requirements.

16.2 A flue baffle shall be accessible for cleaning. A flue baffle which is removable for cleaning shall be such as to facilitate its removal and permit replacement only in a safe position.

17 Flue Collar

17.1 A flue collar of an air heater shall be constructed and arranged to permit the secure attachment of the chimney connector to the heater.

17.2 A flue outlet of a heater shall be vertical and so located that when a vertical flue pipe is connected, the flue pipe will be not less than 9 inches (229 mm) from a vertical wall when any side of the heater is placed as close to the wall as the base, frame, or housing of the heater will permit.

17.3 A flue collar or flue collector parts within the air handling compartment shall have the rigidity, heat resistance, and corrosion resistance at least equivalent to that of sheet steel having a thickness of not less than 0.042 inches (1.07 mm) (No.18 MSG).

18 Damper and Draft Regulator

18.1 An adjustable damper shall be equipped with minimum and maximum operating stops. The minimum operating stop for such damper shall be located to obtain sufficient air for complete combustion at minimum burner input.

18.2 An automatically operated damper shall maintain a safe damper opening at all times and be arranged to prevent starting of the burner unless the damper is in a safe position for starting.

19 Ducts

19.1 An outlet duct for a direct-fired heater shall be of material equivalent to metal having a melting point of not less than 950°F (510°C). A duct provided as part of an air heater shall conform to the following:

- a) It shall be made from metal or mineral base material.
- b) It shall not be subject to deterioration from mildew or moisture.
- c) It shall be no more combustible than flame-resistant fabric conforming to the applicable requirements in Standard Methods of Fire Tests for Flame Propagation of Textiles and Films, NFPA 701.

19.1 revised December 13, 2005

20 Controls

20.1 Application

20.1.1 A safety control circuit shall be two-wire, one side grounded, having a nominal voltage of 120. A safety control or protective device shall interrupt the ungrounded conductor.

20.1.2 It is the intent of the requirement in 20.1.1 that a short circuit or combination of short circuits to ground will not render a safety control or protective device inoperative. Safety control circuit arrangements other than described in 20.1.1 may be acceptable if they accomplish the intent of this requirement.

20.1.3 The requirement of 20.1.1 does not apply to a circuit within a safety control or to the extension of a circuit to a separate element of the control, such as a flame-sensing device.

20.1.4 A control circuit shall be arranged so that it may be connected to a power supply branch circuit that can be fused at not more than the value appropriate for the rating of any control included in the circuit.

20.1.5 All safety controls shall be accessible.

20.1.6 A safety control and its sensing element shall be supported in such manner to remain in its intended proper position. It shall be possible to determine by observation or test whether or not each control is in its proper location.

20.1.7 Nothing shall be provided for the purpose of permitting any safety control to be rendered ineffective or to allow firing of the heater without the protection of each of the required safety controls.

20.1.8 A burner not equipped to provide automatic restarting shall be arranged to require manual restart after any control functions to cause the fuel interrupted power supply.

20.2 Limit control

20.2.1 A heater shall be provided with an integral limit control to prevent excessive temperature.

20.2.2 The maximum setting of a limit control allowed by a fixed stop shall permit an outlet-air (or air and combustion products) temperature of not more than the temperature for which the heater is intended.

20.2.3 An automatically fired heater shall be provided with a recycling type limit control unless the heater is constructed so that equilibrium output temperature is obtained during the Limit Control Cutout Test, Section 41, at a value lower than the appropriate value specified in 40.1.

20.2.4 A safety limit control which functions to interrupt or reduce the delivery of fuel for combustion by opening an electrical circuit shall be so arranged as to effect the direct opening of that circuit, whether the switching mechanism is integral with the sensing element or remote from same.

20.2.5 The purpose of the above requirement is to avoid interposing in the limit-control circuit other controls, the malfunction of which may result in the limit control's not operating as intended.

20.2.6 A heater equipped with a vaporizing burner shall be constructed to avoid pooling of the burner upon functioning of the limit control.

20.3 Primary safety control

20.3.1 An automatically lighted heater and one intended for use where a competent attendant will not be on duty constantly in the room where the heater is located, while it is in operation, shall be equipped with a suitable primary safety control.

20.3.2 A constant-level valve shall be capable of maintaining the oil level to within $\pm 1/32$ inch (0.8 mm) of the intended oil level during operation of the heater.

20.3.3 A heater equipped with an antiflooding device shall be constructed so that when the heater is level, the minimum distance between the intended maximum oil level maintained by the oil-control device and the level of the lowest point at which overflow may occur is not less than $3/4$ inch (19.1 mm).

21 Field Wiring

21.1 General

21.1.1 Provision shall be made for connection of a wiring system that would be acceptable for power supply in accordance with the National Electrical Code, ANSI/NFPA 70.

21.1.1 revised December 13, 2005

21.1.2 The location of an outlet box or compartment in which field wiring connections are to be made shall be such that these connections may be inspected after the equipment is installed as intended.

21.1.3 The connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made. A component intended for such use may serve as a cover.

21.1.4 A cord furnished for connecting a heater to the electrical supply shall be Type SO or the equivalent, and facilities shall be provided for stowing the cord when not in use. An attachment-plug cap shall be of an acceptable type.

21.1.5 The size of a junction box in which field-installed conductors are to be connected by splicing shall not be less than that specified in Table 21.1. A conductor passing through the box is to be counted as one conductor, and each conductor terminating in the box is also to be counted as one conductor. A field furnished conductor for high-voltage circuits is considered to be not smaller than 14 AWG (2.1 mm²).

21.1.5 revised December 13, 2005

Table 21.1
Size of junction boxes

Size of conductors		Free space within box for each conductor,	
AWG	(mm ²)	cubic inches	(cm ³)
16 or smaller	(1.3 or less)	1.5	(24.6)
14	(2.1)	2.0	(32.8)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.3)	3.0	(49.2)

21.1.6 A knockout for connection of a field wiring system to a terminal box or compartment shall accommodate conduit of the trade size specified in Table 21.2.

Table 21.2
Trade size of conduit in inches^a

Wire size		Number of wires				
		2	3	4	5	6
AWG	(mm ²)					
14	(2.1)	1/2	1/2	1/2	1/2	1/2
12	(3.3)	1/2	1/2	1/2	3/4	3/4
10	(5.3)	1/2	1/2	1/2	3/4	3/4
8	(8.4)	3/4	3/4	3/4	1	1
6	(13.3)	3/4	1	1	1-1/4	1-1/4
4	(21.2)	1	1	1-1/4	1-1/4	1-1/2
3	(26.7)	1	1-1/4	1-1/4	1-1/2	1-1/2
2	(33.6)	1	1-1/4	1-1/4	1-1/2	2
1	(42.4)	1-1/4	1-1/4	1-1/2	2	2
0	(53.5)	1-1/4	1-1/2	2	2	2-1/2
2/0	(67.4)	1-1/2	1-1/2	2	2	2-1/2
3/0	(85.0)	1-1/2	2	2	2-1/2	2-1/2
4/0	(107.2)	2	2	2-1/2	2-1/2	3

^a This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

21.1.7 A box or enclosure included as part of the assembly and in which a branch circuit supplying power to the heater is to be connected shall not require that it be moved for intended care of the unit. This requirement does not apply to separate limit controls and stack switches, where permitted, to which metal-clad cable or flexible metallic conduit is to be directly attached.

21.1.8 A box or enclosure in which field-installed conductors are to be connected as indicated in 21.1.7 and 21.1.9 shall be located so that the temperature of conductors within the box or surfaces of the box likely to be in contact with the conductors will not exceed that specified for Type T wire when the heater is tested in accordance with these requirements.

21.1.9 Except as indicated in 22.1.4, wiring to be done in the field between the heater and devices not attached to the heater or between separate devices that are field installed and located shall comply with these requirements if done with Type T wire enclosed in conduit or metal-clad cable.

21.2 Leads and terminals

21.2.1 Wiring terminals or leads not less than 6 inches (152 mm) shall be provided for connection of field wiring conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70, and corresponding to the marked rating of the assembly.

21.2.1 revised December 13, 2005

21.2.2 A lead may be less than 6 inches (152 mm) in length if it is evident that the use of a longer lead may result in a risk of fire or electric shock.

21.2.3 A lead intended for connection to an external circuit shall be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring that may cause the lead to separate from its termination or result in damage to the lead from sharp edges. Each lead shall withstand for 1 minute a pull of 10 pounds (44.5 N) without damage to the assembly.

21.2.4 An identified (grounded) terminal or lead shall not be electrically connected to a single-pole manual switching device which has an OFF position or to a single-pole overcurrent (not thermal) protective device.

21.2.5 At terminals, stranded conductors shall be prevented from contacting other uninsulated live parts and from contacting dead-metal parts. This may be accomplished by use of pressure-terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or equivalent means. Open slot-type connectors shall not be used unless they prevent disconnection resulting from loosening of the clamping means. The shanks of terminal connectors shall be protected by insulating tubing or the equivalent if the required spacings may be reduced as a result of loosening of the clamping means. The thickness of the insulation on the shanks shall be not less than 0.028 inch (0.71 mm).

21.2.6 Field wiring terminals shall be secured to their supporting surfaces by methods other than friction between surfaces so that they will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than those required. This may be accomplished:

- a) By two screws or rivets;
- b) By square shoulders or mortices;
- c) By a dowel pin, lug, or offset;
- d) By a connecting strap or clip fitted into an adjacent part; or
- e) By some other equivalent method.

21.2.7 Conductors intended for connection to a grounded neutral line shall be identified, i.e., finished in a continuous white or gray covering, three continuous white stripes on other than green insulation, or a marking of white or gray color at the termination. All other current-carrying conductors visible to the installer shall be finished in colors other than white, gray, or green. A terminal for connection of a grounded conductor shall be identified by a metallic-plated coating, substantially white in color and shall be readily distinguishable from other terminals, or it shall be identified in some other manner, such as on an attached wiring diagram.

Revised 21.2.7 effective June 13, 2007

21.2.8 Leads provided for spliced connections to an external high-voltage circuit shall not be connected to wire-binding screws or pressure terminal connectors located in the same compartment as the splice or visible to the installer, unless the screws or connectors are rendered unusable for field wiring connections or the leads are insulated at the unconnected ends.

21.2.9 Terminal parts by which field wiring connections are made shall consist of soldering lugs or pressure terminal connectors, secured in place in accordance with 21.2.6, except that for 10 AWG (5.3 mm²) and smaller wires, the parts to which wiring connections are made may consist of clamps or wire binding screws with cupped washers, terminal plates having upturned lugs, or the equivalent, to hold the wire in position.

21.2.9 revised December 13, 2005

21.2.10 A wire binding screw at the high-voltage wiring terminal for field connection shall be not smaller than No. 10 (4.8 mm diameter) except that a No. 8 (4.2 mm diameter) screw may be used for the connection of a conductor not larger than 14 AWG (2.1 mm²) and a No. 6 (3.5 mm diameter) screw may be used for the connection of 16 or 18 AWG (1.3 or 0.82 mm²) control circuit conductors.

21.2.10 revised December 13, 2005

21.2.11 A terminal plate for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) in thickness for a 14 AWG (2.1 mm²) or smaller wire, and not less than 0.050 inch (1.27 mm) in thickness for a wire larger than 14 AWG (2.1 mm²) and in either case there shall be not less than two full threads in the metal.

21.2.11 revised December 13, 2005

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

21.2.13 A wire-binding screw shall thread into metal.

22 Internal Wiring

22.1 General

22.1.1 The wiring of high-voltage circuits shall conform to the requirements in this Section.

22.1.2 Wiring shall be done with insulated conductors having current carrying capacity, voltage, and temperature ratings consistent with their use. A conductor, other than an integral part of a component, shall be not smaller than 18 AWG (0.82 mm²).

22.1.2 revised December 13, 2005

22.1.3 The wiring for all heater circuits shall be furnished by the manufacturer as part of the heater. If the heater is not as assembled and wired at the factory, such wiring shall be furnished as 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.

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

22.2 Methods

22.2.1 Electrical wiring to a part which must be moved for intended 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 connectors. If the wiring to a part which functions also as an access plate or cover, (i.e., a transformer closing the access to the nozzle assembly) is not readily detachable, 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 a part shall not unduly twist, bend, or pull the wiring.

22.2.2 Conductors shall be enclosed within conduit, electrical metallic tubing, metal raceway, electrical enclosure, or metal-clad cable, except as permitted by 22.2.15 and 22.2.16.

22.2.3 Group A of Table 22.1 includes some wiring materials acceptable for use if enclosed as indicated in 22.2.2.

22.2.4 Flexible metal conduit shall not be smaller than 3/8 inch (9.5 mm) electrical trade size. This does not apply to parts of components, such as conduit protecting flame sensor leads, considered under other Standards.

22.2.5 Flexible metal conduit shall be mechanically secured at intervals not exceeding 4-1/2 feet (1.37 m) and within 12 inches (305 mm) on each side or every junction box except for lengths not over 36 inches (914 mm) where flexibility is necessary.

Table 22.1
Typical wiring materials

Table 22.1 revised December 13, 2005

Group	Type of wire, cord or cable	Wire size		Insulation thickness	
		AWG	mm ²	in.	mm
A	RF-2, FF-2, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, RUH, RUW, T, THW, XHHW, MTW, THW-MTW, THWN, TW, or thermoplastic appliance wiring material, with insulation thicknesses shown at the right corresponding to the wire sizes indicated.	10 & Smaller	5.3	2/64	0.8
		8	8.3	3/64	1.2
		6	13.3	4/64	1.6
		4	21.2	4/64	1.6
		3	25.7	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	107.0	5/64	2.0
B	SO, ST, SJO, SJT, or appliance wiring material with thermoplastic or neoprene insulation, with insulation thicknesses shown at the right corresponding to the wire sizes indicated.	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	8.3	6/64	2.4
		6	13.3	8/64	3.2

Table 22.1 Continued on Next Page