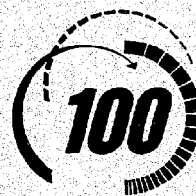


Standard for Safety

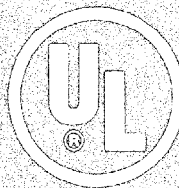
UL 726

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Oil-Fired Boiler Assemblies



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November 30, 1995

Standard for

Oil-Fired Boiler Assemblies

UL 726, Seventh Edition

Accompanying this transmittal notice is a copy of the Seventh edition of UL 726.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

Attention is directed to the note on the title page of this standard identifying that the Department of Defense has adopted the text of UL 726.

Revised and/or additional pages may be issued from time to time.

NOVEMBER 30, 1995

1

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Standard for

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The Department of Defense (DoD) has adopted UL 726 on January 27, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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 published set of revision pages.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

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

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements apply to oil-fired boiler assemblies.

1.2 Requirements for the installation and use of oil-burning equipment are included in the Standard of the National Fire Protection Association for the Installation of Oil-Burning Equipment, NFPA No. 31.

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 General

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

2.2 If a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement. The second value may be only approximate.

3 Glossary

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

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

3.3 **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.

3.4 **APPLIANCE FLUE** — The flue passages within the appliance.

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

3.6 **BAFFLE** — An object placed in an appliance to direct the flow of air or flue gases.

3.7 **BOILER** — A closed vessel in which water or some other liquid is heated or in which steam is generated or superheated, under pressure or vacuum, by direct application of heat.

3.8 **BOILER, HIGH PRESSURE STEAM** — A boiler in which steam is generated at a pressure higher than 15 psig (103 kPa).

3.9 **BOILER, HIGH TEMPERATURE WATER** — A boiler intended for operation at a pressure exceeding 160 psig (1103 kPa) or at a temperature exceeding 250°F (121°C) or both.

3.10 BOILER, HOT WATER – A boiler that furnishes hot water at a pressure not exceeding 160 psig (1103 kPa) and at a temperature not exceeding 250°F (121°C).

3.11 BOILER, LOW PRESSURE STEAM – A boiler in which steam is generated at a pressure not exceeding 15 psig (103 kPa).

3.12 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 burner.

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

3.14 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.

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

3.16 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.

3.17 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, refers to 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 through flameproofed, fire-retardant treated, or plastered.

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

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

3.20 CONTROL, SAFETY – Automatic controls, including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety control system, that is intended to reduce the risk of fire, electric shock, or injury to persons during operation of the controlled equipment.

3.21 CONTROL, PRIMARY SAFETY – An automatic control that monitors the operation of a gas-fired or an oil-fired burner. It normally consists of the following sections that may be integrated into a common unit or may be separate units, interconnected by wiring:

a) **Programming Unit** – A device that programs the burner through start-up and shutdown operations in response to signals from regulating, limiting, and monitoring devices. It also provides the necessary timings, in proper sequence, for purging, pilot flame ignition, main flame ignition, and in case of ignition or flame failure, for safety shutdown (lockout); or

b) **Combustion Detector** – A device that is responsive to flame properties. It monitors the flame at the point of flame supervision and transmits a signal to the programming unit, indicating absence or presence of flame.

3.22 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.

3.23 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.

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

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

3.26 DRAFT – The differential in static pressure available, between any two locations, to provide the energy potential for the moving of air for combustion or products of combustion through a fuel-burning heat-exchanging apparatus, or both.

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

3.28 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 volts peak) or direct current and supplied by:

1) A Class 2 transformer, or by a battery, by a battery and fixed impedance, or by a 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.

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

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

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

3.32 FLUE GASES – Combustion products and excess air.

3.33 FUEL OIL – Any hydrocarbon oil as defined by Commercial Standard CS12 or Specification for Fuel Oils ANSI/ASTM D396-1986.

3.34 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, steam or water) held in close contact with the combustion chamber walls. It is a self-contained combustion and heat transfer device, hence a direct heat exchanger.

3.35 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.

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

3.37 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.

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

3.39 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; and
- e) Replacing igniter cable.

3.40 OIL-FIRED BOILER ASSEMBLY – A boiler assembly as defined herein equipped with one or more oil burners, and all the necessary safety controls, electrical equipment as needed, and related equipment, manufactured for assembly as a unit.

3.41 PILOT – A flame which is utilized to ignite the fuel at the main burner or burners.

3.42 POSTPURGE PERIOD – The period of time after the fuel delivered to the burner is stopped and during which the burner motor or fan continues to run to supply air to the combustion chamber.

3.43 PREPURGE PERIOD – The period of time during the burner start-up in which air is introduced into the combustion chamber and the associated flue passages in such volume and manner as to completely replace the air or fuel-air mixture contained therein prior to initiating ignition.

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

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

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

3.47 SAFETY SHUTDOWN (LOCKOUT) – The shutting off of all fuel and ignition energy to the burner by means of a safety control or controls so that restart cannot be accomplished without manual reset.

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

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

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

3.51 VALVE, MANUAL OIL SHUT-OFF – A manually operated valve in the oil line for the purpose of completely turning on or shutting off the oil supply to the burner.

3.52 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.

3.53 VENTED APPLIANCE – An indirect fired appliance provided with a flue collar to accommodate a chimney connector for conveying flue gases to the outside air.

4 Components

4.1 Except as indicated in 4.2, 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.

4.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard; or
- b) Is superseded by a requirement in this standard.

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

4.4 Specific components are recognized as being 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 for which they have been recognized.

4.5 Except as indicated in 4.6, a component of a product covered by this standard, including the oil burner and its primary safety control as assembled as part of a boiler assembly, 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.

4.6 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard; or
- b) Is superseded by a requirement in this standard.

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

4.8 Specific components are recognized as being 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 for which they have been recognized.

CONSTRUCTION

5 Assembly

5.1 A boiler assembly 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 boiler assembly may be shipped as two or more major subassemblies. The boiler of an oil-fired boiler assembly shall be constructed, equipped, inspected, tested, and marked in accordance with the 1992 ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers or Section IV, Heating Boilers, whichever is appropriate.

5.2 A boiler assembly, if not assembled by the manufacturer as a unit, shall be arranged in major subassemblies. See 5.3. Each subassembly shall be capable of being incorporated into the final assembly without requiring alteration, cutting, drilling threading, welding, or similar tasks by the installer. Two or more subassemblies, which must bear a definite relationship to each other for the intended installation or operation of the boiler assembly, 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 alteration or alignment, or such subassemblies shall be assembled, tested, and shipped from the factory as one element.

5.3 To be in accordance with 5.2, major subassemblies of a boiler assembly are deemed to be the burner and the heat exchanger sections of a cast iron sectional boiler including its base, combustion chamber, casing, and safety controls. A wiring harness may be packaged with one of the major subassemblies.

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

5.5 A boiler assembly shall be such that, for any normal installation, the alteration or removal of a baffle, insulation, or a radiation shield needed to prevent unsafe temperatures is not required.

5.6 A boiler assembly shall afford convenient operation by the user of those parts requiring attention or manipulation in normal usage.

5.7 Adjustable or movable parts shall be provided with locking devices to prevent unintentional shifting.

5.8 Screws or bolts used to attach parts which are detached for normal care or servicing of the appliance shall be capable of holding upon the application of the torques indicated in Table 5.1 after removal and replacement.

Table 5.1
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	(44.5)
7/16 inch	(11.1)	550	(62.1)
1/2 inch	(12.7)	800	(90.3)
9/16 inch	(14.3)	1200	(135.5)

5.9 An external door, providing access into the combustion chamber of a boiler assembly intended for installation with a clearance of less than 24 inches (610 mm) from the face of or 48 inches (1.22 m) above the door, shall be self-closing.

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

6 Accessibility for Servicing

6.1 A boiler assembly shall be built to allow cleaning of parts such as heating surfaces in contact with combustion products, and oil strainers, without major dismantling of the boiler assembly or removal of parts required by 5.2 to be factory-assembled.

6.2 The removal of access panels, burners, caps, plugs, etc., specifically designed to permit ready removal and replacement for servicing, and the detachment of the chimney connector are not considered major dismantling as defined by 6.1.

6.3 Sufficient and reasonable accessibility shall be afforded for cleaning, inspection, repair, and replacement of all burners, controls, and safety devices when the boiler assembly is installed as recommended by the manufacturer. The disposition of parts in the assembly removed for normal care shall be such that their restoration, following removal, will not necessitate their realignment to secure their proper relationship with other parts of the assembly. Special facilities required for normal care to be done by the operator shall accompany the boiler assembly to the user.

7 Casing

7.1 The outer casing or jacket shall be made of steel or equivalent material, braced, reinforced or formed so that it is not likely to be damaged through handling in shipment, installation, and use. Sheet metal casings shall be made of steel at least 0.020 inch (0.51 mm) (No. 24 MSG) thick if uncoated, or 0.023 inch (0.58 mm) (No. 24 GSG) if galvanized, or of nonferrous sheet metal having an average thickness of not less than 0.029 inch (0.74 mm).

7.2 Access panels that need 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.

7.3 A removable panel through which air is drawn for combustion shall be so constructed as to prevent it from being attached in a manner that may cause unsafe performance of the boiler assembly.

7.4 A removable panel shall be so constructed that it will not be interchangeable with other panels on the same boiler when interchange may allow unsafe operation of the boiler assembly.

7.5 The casing of a boiler assembly for installation on combustible flooring shall completely close the bottom or be constructed to provide an effective radiation barrier between the heat exchanger and the floor.

8 Radiation Shields or Liners

8.1 A radiation shield or liner shall be so constructed, formed, and supported as to ensure proper positioning and to prevent distortion or sagging in service. A shield or liner shall be protected against corrosion if its deterioration may cause excessive temperature when the boiler assembly is tested in accordance with these requirements. Any finish to obtain the required resistance to corrosion shall not be damaged by heat when the boiler assembly is tested under these requirements.

8.2 Thermal insulation which is not adequately self-supporting shall be applied to solid surfaces in a manner so as to prevent sagging. The insulating value of the material shall be unimpaired when the boiler assembly is tested under these requirements.

8.3 An adhesive for attaching insulating material shall retain its adhesive qualities at any temperature the adhesive may attain when the unit is tested under these requirements and at 0°F (minus 17.8°C).

9 Combustion Chamber

9.1 A combustion chamber and flueway shall be constructed of cast iron, sheet steel, or of a material equivalent in mechanical properties and corrosion resistance. Plain carbon sheet steel, if used, shall be at least 0.042 inch (1.07 mm) (No. 18 MSG) thick.

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

10 Baffles

10.1 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 ANSI 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 or deleterious performance characteristics when the boiler assembly is tested in accordance with these requirements.

10.2 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.

11 Flue collar

11.1 A flue collar shall be constructed and arranged to permit the secure attachment of the chimney connector to the boiler assembly.

12 Damper and Draft Regulator

12.1 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.

12.2 An automatically operated damper shall be designed to 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.

12.3 A boiler assembly to be equipped with a barometric draft regulator shall be designed so as not to require the regulator to be installed in a false ceiling, in a different room, or in any manner that will permit a difference in pressure between the air in the vicinity external to the regulator and the combustion air supply.

13 Controls

13.1 Application

13.1.1 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.

13.1.2 It is the intent of the requirement in 13.1.1 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 13.1.1 may be considered if they accomplish the intent of this requirement.

13.1.3 The requirement of 13.1.1 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.

13.1.4 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.

13.1.5 All safety controls shall be accessible.

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

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

13.1.8 A burner not equipped to provide safe automatic restarting shall be arranged to require manual restart after any control functions to cause the fuel supply to be shut off and after restoration of an interrupted power supply.

13.1.9 A boiler assembly shall be provided with operating controls that regulate the fuel supply so as not to exceed the rated operating temperature or pressure as specified in 13.1.10 – 13.1.12.

13.1.10 A steam boiler shall be provided with at least one steam pressure actuated control that will shut off fuel supply to the burner when the steam pressure in the boiler reaches a preset maximum operating pressure. This requirement does not preclude the use of additional operating controls, if required.

13.1.11 A water boiler shall be provided with at least one temperature actuated control to shut off the fuel supply to the burner when the temperature of the water in the boiler reaches a preset operating temperature. This requirement does not preclude the use of additional operating controls, if required.

13.1.12 If a boiler assembly is equipped with an operating control that only regulates the fuel input between high and low values of steam pressure or water temperature, an additional operating control set to shut off the equipment at a value below the set point of the limit control is required.

13.1.13 An operating control need not be factory-installed provided the wiring diagram and instructions furnished with the boiler indicate that an operating control of an appropriate type and setting is to be furnished by the installer. See 48.3.

13.2 Limit controls

13.2.1 A boiler shall be provided with limit controls that operate to shut off fuel and cause safety shutdown in case of a low water condition and excessive temperature or excessive pressure, as specified in 13.2.2 – 13.2.4 and 13.4.1 – 13.6.1. The limit controls shall be in addition to any operating controls specified in 13.1.9 – 13.1.13.

13.2.2 With respect to 13.2.1, safety shutdown may be provided either by employing manual reset type limit controls or it may be effected remotely by utilizing the manual reset feature of another control, such as the primary safety control. For systems where the reset feature is remote from the limit control, means shall be provided to indicate the limit control has operated when it causes safety shutdown.

13.2.3 A limit control that 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 or remote from the sensing element.

13.2.4 The purpose of the requirement in 13.2.3 is to avoid interposing in the limit-control circuit other controls, the failure of which may result in a condition that the limit control is intended to prevent. However, a limit control may interrupt the pilot circuit of a magnetic-type motor controller which, in turn, directly opens the safety circuit when it is necessary to interrupt a single-phase circuit carrying a load greater than the capacity of available limit controls or to interrupt a multiphase circuit.

13.2.5 The limit control for a boiler for alcove or closet installation shall be factory-located on the assembly or its location shall be factory-predetermined.

13.3 Primary safety control

13.3.1 An oil-fired boiler assembly shall be provided with a primary safety control to program and monitor the burner operation in accordance with 13.3.2 – 13.3.7 and Table 13.1. The primary safety control may be integral with the oil burner or it may be integrated into the boiler assembly.

13.3.2 The operation of the primary safety control shall be such that after the end of the main burner flame establishing period the combustion detector is responsive only to the properties of main burner flame.

Table 13.1
Required programming and timings for
burners based on maximum fuel input rating

	Maximum Input		
Operation	3 gph (11.4 L/h) or less	Above 3 to 20 gph (above 11.4 to 75.7 L/h)	Above 20 gph (above 75.7 L/h)
	Approximately 400,000 Btu/h (117 kW) ^a or less	Above approximately 400,000 Btu/h to approximately 3,000,000 Btu/h (879 kW)	Above approximately 3,000,000 Btu/h
Prepurge	Not required	Up to 7 gph (26.5 L/h) not required Over 7 gph required if oil pump operates independently of the burner. See 13.7.1.	Four air changes at 60 percent damper opening and with proven air flow. See 13.7.2.
Postpurge timing	Not required	Not required	15 seconds minimum
Pilot type and flame establishing period ^b	Not applicable	Interrupted, 10 seconds maximum	Interrupted, 10 seconds maximum
Main burner flame establishing period			
Ignited by pilot	Not applicable	15 seconds maximum ^c	10 seconds maximum for Nos. 2 and 4 oil, 15 seconds maximum for Nos. 5 and 6 oil ^d
Direct ignition	90 seconds maximum	15 seconds maximum	Not permitted except for low fire start up to 20 gph, in which case 15 seconds maximum ^e
Flame failure reaction time ^f			
Ignited by pilot	Not applicable	4 seconds maximum	4 seconds maximum
Direct ignition	90 seconds maximum	15 seconds maximum for inputs up to 7 gph 4 seconds maximum for inputs over 7 gph	4 seconds maximum
Fuel valve closing time after de-energization	Not Applicable	5 seconds maximum	1 second maximum
Action required on flame failure	One relight attempt permitted; if flame not proved shall lock out	One recycle permitted if flame failure response time does not exceed 4 seconds.	Safety shutdown required.
Proven low fire start	Not required	Not required	Required with direct ignition if total input exceeds 20 gph.
Combustion air proving	Not applicable	Required if fan is not mounted on burner motor shaft	Required
Action required on loss of combustion air	Not applicable	Safety shutdown except may recycle once. See 13.7.4.	Safety shutdown

(Continued)

Table 13.1 (Cont'd)
Required programming and timings for
burners based on maximum fuel input rating

	Maximum Input		
Oil pressure supervision	Not applicable	Not required	Required if oil pump is remote from burner motor. See 13.7.6.
Low atomizing media pressure supervision	Not applicable	Required unless atomization is accomplished by oil pump mounted on burner motor shaft. See 13.7.7.	Required. See 13.7.7.
Oil temperature supervision	Not applicable	High and low temperature supervision required on preheated oil. Excessive temperature shall cause safety shutdown.	

^a Oil burners used for inputs up to 3 gph normally employ direct ignition of oil at fuel input. They are not required to employ any interlocks for monitoring of oil pressure or temperature, pressure of atomizing media or for proving combustion air. Therefore, the requirements included in this table for such operations are not applicable to these burners.

^b Continuous and intermittent pilots are permitted if only the main burner flame is monitored during the burner operation. See 13.3.2.

^c Use of pilot for igniting the main flame is optional for inputs of 20 gph or less. See 13.3.7.

^d If it can be demonstrated by tests that a burner equipped to fire No. 5 or 6 oil needs more than 15 seconds for the main burner flame establishing period in order to avoid nuisance shutdown, the period may be extended to 30 seconds provided not more than 15 seconds of unburned fuel can be discharged during an attempt to establish the main flame.

^e See 13.3.7.

^f The flame failure reaction timing is to be based on the burner's maximum input. The flame-failure reaction time for burners having inputs in excess of 3 gph it is to be considered the interval between the actual flame extinguishment and the time the safety shutoff device (such as an oil valve) is de-energized. For burners having inputs of 3 gph or less the timing may be considered the interval measured from the time the flame sensing device (detector) first detects the loss of flame, to the time the safety shutoff device is de-energized.

13.3.3 For a boiler having an input exceeding 3 gph (11.41 L/h), loss of flame at the point of supervision shall result in the shutting off of all fuel to the burner. For a boiler having:

- a) An input not exceeding 3 gph; and
- b) Interrupted spark ignition, the ignition may be reactivated in not more than 0.8 second following the flame failure for an attempt to relight the burner.

If flame is not established, safety shutdown shall occur. See 13.3.4 and 13.3.5 for action required with other inputs.

13.3.4 With respect to 13.3.3, for a boiler having an input not exceeding 20 gph (75.7 L/h) and that is equipped to provide prepurge, on flame failure one additional attempt may be made to ignite the burner after a prepurge in accordance with 13.7.2. If flame is not established, safety shutdown shall occur.

13.3.5 With respect to 13.3.3, for a boiler having an input in excess of 20 gph (75.7 L/h), on flame failure no additional attempts to relight the burner shall be made and safety shutdown shall occur.

13.3.6 When an automatically ignited pilot is used, the pilot flame shall be proved before the main fuel valve is energized. Fuel to the pilot shall be shut off and safety shutdown shall occur if the pilot flame is not proved.

13.3.7 Direct ignition of the main burner shall not be employed for inputs in excess of 20 gph (75.7 L/h).

Exception: Direct ignition may be used on a boiler assembly having an input in excess of 20 gph if:

- a) The initial ignition is accomplished at a input not exceeding 20 gph; and*
- b) The input is not increased until the main flame at the lower input has been established and proved.*

13.4 Liquid level limit controls

13.4.1 A water boiler shall be provided with at least one low water cut-off or combination low water cut-off and water feed control that operates to open the burner circuit and cause safety shutdown before the water falls below the lowest permissible level as specified in 13.4.2.

Exception No. 1: A low-water fuel cutoff control is not required to be furnished on a water boiler that has a main flame hourly input of not more than 400,000 Btu's per hour (117 kW) or 2.85 gallons per hour (10.8 L/h).

Exception No. 2: A water tube or coil type boiler that requires forced water circulation to guard against excessive temperatures (see 13.6.1), may employ a water flow sensing device instead of a low water cut-off.

13.4.2 Low pressure and high pressure steam boilers shall be provided with at least two low water cut-offs or combination low water cut-off and water feed controls. Both controls shall be wired electrically so that operation of either control causes fuel cut-off to the burner before the water level falls below the lowest visible part of the gage glass. However, one control shall be set to operate at a lower water level than the other. The control set lower shall cause safety shutdown, requiring a manual reset to restore burner operation.

Exception: A boiler that does not exceed any of the following limits may be provided with only one low water cut-off:

- a) Maximum working pressure – 100 psig (689.5 kPa);*
- b) Maximum inside diameter of shell – 16 inches (406.4 mm);*
- c) Maximum heating surface – 20 square feet (1.86 m²); and*
- d) Gross volume, exclusive of casing and insulation – 5 cubic feet (0.142 m³). See 13.4.3.*

13.4.3 With reference to the exception to 13.4.2, the gross volume is considered to be the volume of a rectangular or cylindrical enclosure into which all the pressure parts of the boiler could be fitted in their final assembly including gas passages that are integral with the assembled pressure parts. Projecting nozzles or fittings need not be considered in this volume.

13.4.4 With respect to 13.4.1 and 13.4.2, safety shutdown may occur simultaneously with the operation of the low water cut-off to shut down the burner or it may incorporate a time delay. The time delay for safety shutdown shall not exceed the boiler manufacturer's recommended time or 90 seconds, whichever is less.

13.5 Pressure limit controls

13.5.1 Each low pressure and high pressure steam boiler shall be provided with a pressure operated control that operates to shut off all fuel to the burner and cause safety shutdown in case of excessive steam pressure in the boiler. The control settings shall be in accordance with 13.5.2 and 13.5.3, as appropriate.

13.5.2 The maximum setting of a limit control on a low-pressure steam boiler shall limit the steam pressure in the boiler to 15 psig (103 kPa). On a control having an adjustable setpoint, the maximum setting shall be limited by a fixed stop.

13.5.3 The limit control for a high pressure steam boiler shall limit the steam pressure in the boiler to the maximum allowable working pressure of the boiler. On a control having an adjustable setpoint, the maximum setting shall be limited by a fixed stop.

13.6 Temperature limit controls

13.6.1 A water boiler shall be provided with at least one temperature-operated limit control that operates to shut off all fuel to the burner and cause safety shutdown before the water temperature in the boiler exceeds the maximum rated operating temperature. For a low pressure hot water boiler safety shutdown shall occur before the water temperature in the boiler exceeds 250°F (121°C).

13.7 Purge and combustion air monitoring controls

13.7.1 A boiler assembly having an input rating in excess of 7 gph (26.5 L/h) but not exceeding 20 gph (75.7 L/h) shall be equipped to provide prepurge of sufficient length to assure four air changes in the combustion chamber and associated flue passages. The purging shall be accomplished with either proven air flow in not less than 90 seconds or at a damper opening of not less than 60 percent with both the air flow and the damper position proven.

13.7.2 A boiler assembly having an input rating in excess of 20 gph (75.7 L/h) shall be equipped to provide a prepurge of sufficient length to assure four air changes in the combustion chamber and associated flue passages. The purging shall be accomplished at a damper opening of not less than 60 percent with both the air flow and the damper position proven. Such a boiler shall also be equipped to provide a postpurge period of not less than 15 seconds.

13.7.3 The purging periods required by 13.7.1 and 13.7.2 shall either be provided as part of the primary safety control programming or by a separate device, arranged so that the ignition of the burner cannot be initiated if the device has failed in a manner that will not provide purging in accordance with 13.7.1 and 13.7.2.

13.7.4 For a boiler assembly having an input in excess of 20 gph (75.7 L/h), loss of combustion air shall result in safety shutdown. For a boiler assembly having an input in excess of 3 gph (11.4 L/h) but less than 20 gph, on which the forced or induced draft fan that supplies combustion air is not integral with the burner motor shaft, loss of combustion air shall result in fuel shutoff to the burner.

13.7.5 For convenient reference, the requirements for purge and action required on loss of combustion air are also included in Table 13.1.

13.7.6 A boiler having an input rating in excess of 20 gph (75.7 L/h) shall employ a low oil pressure interlock switch that shall cause safety shutdown when the oil pressure falls below the predetermined limit.

Exception No. 1: A low pressure interlock is not required for rotary cup type burners.

Exception No. 2: A low pressure interlock switch is not required if the oil pump is secured directly on the burner motor shaft.

13.7.7 A boiler having an input rating in excess of 3 gph (11.4 L/h) shall be provided with a low pressure interlock switch for the atomizing media that shall cause safety shutdown when the pressure falls below the predetermined limit.

Exception: A low pressure interlock switch is not required on systems that employ pressure atomization of oil, provided the oil pump is secured directly on the burner motor shaft and the input does not exceed 20 gph (75.7 L/h).

13.7.8 High and low temperature interlocks shall be provided for systems that fire preheated oil. An oil temperature in excess of the limit established by the burner manufacturer shall result in safety shutdown. If the oil temperature falls below the predetermined limit, the interlock shall operate to stop fuel delivery to the burner and allow circulation of the oil until the temperature increases to permit firing.

13.7.9 With respect to 13.7.5 – 13.7.7, for convenient reference the requirements for temperature and pressure switches are also included in Table 13.1.

13.8 Safety shut-off valves

13.8.1 The oil fuel train of each boiler assembly having an input in excess of 3 gph (11.4 L/h) shall be provided with two oil safety shut-off valves or one safety shut-off valve and a nozzle cut-off valve. The closing times of the shut-off valves shall not exceed the timings specified in Table 13.1. The pressure rating of the shut-off valves shall not be less than the maximum pump pressure.

13.8.2 A safety shut-off valve that is responsive to pressure variations in a hydraulic or pneumatic remote control system shall close upon failure of pressure in the control system.

14 Installation of External Controls and Fittings

14.1 If a low water cutoff is installed external to a low pressure or a high pressure steam boiler utilizing a water column, the connecting piping and fittings to the column shall not be smaller than 1-inch NPS and no shutoff valves of any type shall be placed in the piping between the boiler and the cutoff. A cross or equivalent fitting shall be used in the piping connections at every right angle to facilitate cleaning and inspection.

14.2 A low water cutoff that embodies a separate chamber shall incorporate a vertical drainpipe and a blowoff valve not smaller than 3/4-inch NPS, located at the lowest point of the chamber or water-equalizing pipe connections so that the chamber and the equalizing pipe can be flushed and the low water cutoff can be tested for operation.

14.3 A low water cutoff or a combination cutoff and water feed control for a low pressure steam boiler may be installed in the tapped openings provided for attachment of a water gage glass directly to the boiler. For such installation, the connections shall be made with nonferrous "T" or "Y" fittings for the low water cutoff connections. The ends of any nipples used shall be hollowed to full size of the internal diameter.

14.4 For a hot water heating boiler, the low water cutoff may be installed external to the boiler. Under low water conditions, the chamber in which the cutoff is located shall drain so as to maintain the same water level as in the boiler, and if flow occurs in the chamber, it will be in the upward direction.

14.5 A water feed control, when used, shall be constructed and installed so that the water inlet valve cannot feed water into the boiler through a float chamber of a low water cutoff or through the connections of such float chamber.

14.6 A steam pressure limit control shall be installed on the boiler without any shutoff valve between the limit control and the boiler.

14.7 Each steam pressure limit control shall be protected with a siphon or equivalent means of maintaining a water seal between the steam and the inlet to the control. The size of the siphon shall not be less than 1/4-inch NPS. Tubing of adequate temperature and pressure rating and of equivalent inside diameter may be substituted for pipe.

14.8 If a steam pressure limit control that incorporates a mercury switch is mounted on a siphon, the loop of the siphon shall be in a plane that is 90 degrees (1.57 rad) from the plane of the mercury switch.

14.9 The steam pressure connections to the steam pressure limit control shall not be:

- a) Smaller than 1/4-inch NPS, if the pipe is of nonferrous material;
- b) Smaller than 1/2-inch NPS, for ferrous materials up to 5 feet (1.5 mm) in length; or
- c) More than 1-inch NPS for ferrous materials over 5 feet in length.

Tubing of adequate temperature and pressure rating and of equivalent internal diameter may be substituted for pipe.

14.10 When multiple pressure controls, (i.e. pressure limit and pressure operator controls) are fed from a common manifold, the manifold and common source connection feeding the manifold shall be one NPS pipe size larger than the NPS pipe size used to connect the pressure limit control for compliance with 14.9. A suitable sized reducing bushing may be used in the piping connection between the manifold and the pressure limit control.

15 Field Wiring

15.1 General

15.1.1 Provision shall be made for connection of a wiring system that would be suitable for power supply in accordance with the National Electrical Code, ANSI/NFPA 70-1990.

15.1.2 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.

15.1.3 The connections shall 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 use as the cover of an outlet box or compartment may serve as a cover.

15.1.4 The size of a junction box in which field-installed conductors are to be connected by splicing shall be not less than that indicated in Table 15.1. A conductor passing through the box is counted as one conductor, and each conductor terminating in the box is also counted as one conductor. A field-furnished conductor for high-voltage circuits is considered to be not smaller than No. 14 AWG (2.1 mm²).

Table 15.1
Size of junction boxes

Size of conductor		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)

15.1.5 A knockout for connection of a field wiring system to a terminal box or compartment shall accommodate conduit of the trade size determined by applying Table 15.2.

15.1.6 Wiring exterior to a boiler assembly between the burner assembly and a limit control, a primary safety control, or a motor controller, that can be done readily with a wire enclosed in conduit or with metal-clad cable in accordance with the National Electrical Code, ANSI/NFPA 70-1990, need not be furnished by the manufacturer as part of the boiler assembly if adequate instructions for installing such wiring are furnished with each boiler assembly. See 16.1.4.

15.1.7 A box or enclosure, included as part of the assembly and in which a branch circuit supplying power to the boiler assembly is to be connected, shall not require that it be moved for normal 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.

15.1.8 A box or enclosure in which field installed conductors are to be connected as indicated in 15.1.5, 15.1.6, 15.1.7, and 15.1.9 shall be so located 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 a wire having a 60°C (140°F) temperature rating when the boiler assembly is tested in accordance with these requirements.

15.1.9 Except as otherwise permitted by 16.1.4, wiring to be done in the field between the boiler and devices not attached to the boiler assembly or between separate devices which are field installed and located, shall conform to these requirements if done with a 60°C (140°F) rated wire enclosed in suitable conduit or metal-clad cable.

Table 15.2
Trade size of conduit in inches

Wire size		Number of wires				
AWG	(mm ²)	2	3	4	5	6
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	1	1	1-1/4
6	(13.3)	3/4	3/4	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	1-1/4	1-1/2	1-1/2
2	(33.6)	1	1	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	1-1/4	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	1-1/2	2	2-1/2	2-1/2
4/0	(107.2)	2	2	2-1/2	2-1/2	3

NOTE — 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.

15.1.10 The wiring of the appliance may terminate in a length of flexible metal conduit with an outlet box, control box, or equivalent enclosure intended for connection of the product to the wiring system specified in 15.1.1. If the conduit terminates in an outlet box larger than 4 by 4 by 2 inches (102 by 102 by 51 mm) for splice connection, locknuts on the fittings are not acceptable as a means to prevent loosening of the conduit fittings. A grounding conductor of the size specified in the National Electrical Code, ANSI/NFPA 70-1990, shall be included unless:

- The total length of flexible metal conduit of any ground return path in the product is not more than 6 feet (1.83 m);
- No circuit conductor protected by an overcurrent-protective device rated at more than 20 amperes is included; and
- The conduit is no larger than 3/4 inch trade size, or the fittings for the conduit are identified as providing grounding.

15.2 Leads and Terminals

15.2.1 Wiring terminals or leads not less than 6 inches (152 mm) long for connection of field-wiring conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70-1990, corresponding to the marked rating of the assembly shall be provided.

15.2.2 Leads may be less than 6 inches (152 mm) in length if it is evident that the use of a longer lead might result in a risk of fire, electric shock, or injury to persons.

15.2.3 Leads 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 which may cause the lead to separate from its termination or result in damage to the lead from sharp edges. Each lead shall be capable of withstanding a pull of 10 pounds (44.5 N) for 1 minute without damage to the assembly.

15.2.4 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.

15.2.5 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. An open slot-type connector shall not be used unless it is constructed to reduce the likelihood of 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).

15.2.6 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 by two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by some other equivalent means.

15.2.7 Conductors intended for connection to a grounded neutral line shall be identified, that is, finished a white or natural gray color. All other current-carrying conductors visible to the installer shall be finished in colors other than white, natural 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.

15.2.8 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.

15.2.9 Terminal parts by which field-wiring connections are made shall consist of soldering lugs or pressure terminal connectors secured in place in accordance with the requirements in 15.2.5:

Exception: For No. 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.

15.2.10 A wire binding screw at a high-voltage wiring terminal for field connection shall not be smaller than No. 10 (4.8 mm major diameter).

Exception No. 1: A No. 8 (4.2 mm major diameter) screw may be used for the connection of a conductor not larger than No. 14 AWG (2.1 mm²).

Exception No. 2: A No. 6 (3.5 mm major diameter) screw may be used for the connection of a No. 16 or No. 18 AWG (1.3 or 0.82 mm²) control-circuit conductor.

15.2.11 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 No. 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 No. 14 AWG (2.1 mm²); and in either case there shall be not less than two full threads in the metal.

15.2.12 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.

15.2.13 A wire binding screw shall thread into metal.

16 Internal Wiring

16.1 General

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

16.1.2 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 No. 18 AWG (0.82 mm²).

16.1.3 Except as indicated in 15.1.6, the wiring for each boiler assembly circuit shall be furnished by the manufacturer as part of the boiler assembly. If the boiler assembly is not assembled and wired at the factory, such wiring shall be furnished as harness with each boiler and be arranged to facilitate attachment when the boiler is assembled; and a pictorial diagram showing the exact arrangement of the wiring shall be included with each boiler assembly.

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

Methods

16.1.5 Electrical wiring to a part which must be moved for normal 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 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 part shall not unduly twist, bend, or pull the wiring.

16.1.6 Conductors shall be enclosed within conduit, electrical metallic tubing, metal raceway, electrical enclosure, or metal-clad cable, except as permitted by 16.1.19.

Exception: Factory wiring involving a potential of not more than 300 volts between parts attached to the same assembly with a predetermined fixed relationship one to the other may be done with Type SO or ST cord, provided all of the following conditions are fulfilled.

- a) *It is not practical to do the wiring in accordance with 16.1.6;*
- b) *The cord is not required to be bent, twisted, or otherwise displaced to render normal maintenance and service; and*
- c) *The length of cord exterior to the assembly is not more than 4 inches (102 mm) and strain relief is provided.*

16.1.7 Group A of Table 16.1 includes some wiring materials suitable for use if enclosed as indicated in 16.1.6.

16.1.8 Flexible metal conduit, if used, shall be not 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. See 4.1.

16.1.9 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 of every junction box except for lengths not over 36 inches (914 mm) where flexibility is necessary.

16.1.10 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 risk of fire, electric shock, or injury to persons.

16.1.11 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 ensured.

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

16.1.13 Each splice shall be enclosed by being installed in a junction box, control box, or other compartment in which high-voltage wiring materials may be employed.

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

16.1.15 A splice is considered to be adequately enclosed when installed in a junction box, control box, or other enclosed compartment in which wiring materials, as specified in Group A of Table 16.1, may be employed. Splices in enclosed machinery compartments are to be secured to a fixed member in the compartment so that they are not subject to movement or damage during servicing.

16.1.16 At all points where conduit or metal tubing terminates, the conductor 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 metal cladding, and the connector or clamp shall be of such design that the insulating bushing or its equivalent will be visible for inspection.