

Standard for Safety

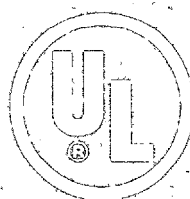
UL 2106

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Field Erected Boiler Assemblies



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October 27, 1994

Standard for

Field Erected Boiler Assemblies

UL 2106, First Edition

Accompanying this transmittal notice is a copy of the First edition of UL 2106.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

The requirements in this standard are substantially in accordance with UL's bulletin on this subject dated May 6, 1994. This bulletin is now obsolete and may be discarded.

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



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OCTOBER 27, 1994

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UL 2106

Standard for

Field Erected Boiler Assemblies

First Edition

October 27, 1994

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 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 field assembled boiler assemblies that are provided with or are intended for installation with single fuel-gas, single fuel-oil, or combination gas-oil burning equipment.

1.2 These requirements apply to fuel burning equipment which require flame failure and other safeguards and which are intended primarily for commercial and industrial installation.

1.3 Equipment covered by these requirements may be operated without a competent attendant being constantly on duty at the equipment while the burners are in operation.

1.4 The appliance shall be suitable for installation in accordance with the Standards for Installation of Oil-Burning Equipment, NFPA 31, and/or National Fuel Gas Code, NFPA 54, and the National Electrical Code, NFPA 70-1993.

1.5 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 may be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

1.6 Equipment covered by these requirements shall be designed, assembled, tested, and inspected in accordance with the requirements of Section I or Section IV of the ASME Boiler and Pressure Vessel Code. Conformance with the code will be determined by application of the "H or "S" stamp and, if applicable the "A" symbol stamp on the appropriate part of the boiler assembly.

1.7 Each field erected boiler shall undergo a final inspection following completion of field assembly, ASME code required testing and inspection, and operational testing. The inspection shall cover all points required by the authority having jurisdiction.

2 General

2.1 Terminology

2.1.1 The term "appliance" or "boiler assembly" refers to any equipment covered by this Standard.

2.1.2 The terms "combustible" and "noncombustible" as used in these requirements, are defined in the Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances, ANSI/NFPA 97M-1988.

2.2 Units of measurement

2.2.1 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 **APPLIANCE FLUE** – The flue passages within the appliance.
- 3.3 **BAFFLE** – An object placed in an appliance to direct the flow of air or flue gases.
- 3.4 **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.
- 3.5 **BOILER ASSEMBLY** – A boiler assembly as defined herein equipped with one or more burners of either the oil or gas type, and all necessary safety controls, electrical equipment as needed, and related equipment, manufactured for assembly as a unit.
- 3.6 **BOILER, HIGH PRESSURE STEAM** – A boiler in which steam is generated at a pressure higher than 15 psig (103 kPa gauge).
- 3.7 **BOILER, HIGH TEMPERATURE WATER** – A boiler intended for operation at a pressure exceeding 160 psig (1103 kPa gauge) or at a temperature exceeding 250°F (121°C) or both.
- 3.8 **BOILER, HOT WATER** – A boiler that furnishes hot water at a pressure not exceeding 160 psig (1103 kPa gauge) and at a temperature not exceeding 250°F (121°C).
- 3.9 **BOILER, LOW PRESSURE STEAM** – A boiler in which steam is generated at a pressure not exceeding 15 psig (103 kPa gauge).
- 3.10 **CASING** – An enclosure forming the outside of the appliance, no parts of which are likely to be subjected to intense heat.
- 3.11 **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.
- 3.12 **COMBUSTION CHAMBER** – The portion of an appliance within which combustion occurs.
- 3.13 **CONTROL, LIMIT** – An automatic safety control, responsive to changes in liquid level, pressure, or temperature, for limiting the operation of the controlled equipment.
- 3.14 **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.
- 3.15 **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).
 - 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.

3.16 **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.

3.17 **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.

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

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

3.20 **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.

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

3.22 **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.

3) **Safety Control Circuit** – A circuit involving one or more safety controls.

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

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

3.25 **FLUE GASES** – Combustion products and excess air.

3.26 **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 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.

3.27 **HEAT EXCHANGER, INDIRECT** – A heat exchanger which encloses or contains a heating medium, such as 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.

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

3.29 **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.

3.30 **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.

3.31 **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.

3.32 **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.

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

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

3.35 **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.

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

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

3.38 **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, including the burner and its primary safety control 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.

4.2 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.

CONSTRUCTION — MECHANICAL

5 Assembly

5.1 General

5.1.1 A field erected boiler shall include all the essential components necessary for its assembly and normal function when installed and constructed as intended. The pressure vessel shall be constructed, equipped, inspected, tested, and marked in accordance with the ANSI/ASME Boiler and Pressure Vessel Code, Section I, Power Boilers or Section IV, Heating Boilers, whichever is appropriate.

5.1.2 A boiler assembly shall be arranged in major subassemblies. See 5.1.3. Each subassembly shall be capable of being incorporated into the final assembly without requiring alteration, cutting, drilling, threading, or similar tasks by the installer. When welding is required to join major subassemblies, such welding shall be undertaken only by qualified/certified welders and the welding process shall be inspected by the local authority having jurisdiction and/or authorized inspection agency. 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.

5.1.3 To be in accordance with 5.1.2, major subassemblies of a boiler assembly intended to be constructed in the field are considered to be the burner, (heat exchanger sections of a cast iron sectional boiler including its base,) pressure vessel, flue tubes, water tubes, combustion chamber, casing, safety controls and wiring harness.

5.1.4 A radiation shield or baffle employed to reduce the risk of 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.

5.1.5 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 reduce the risk of temperatures not intended during operation is not required.

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

5.1.7 Adjustable or movable parts shall be provided with locking devices to reduce the risk of unintentional shifting.

5.1.8 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)

5.1.9 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.

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

5.2 Moving parts

5.2.1 Moving parts such as fan blades, blower wheels, pulleys, belts, etc., which may cause injury shall be enclosed or guarded.

5.2.2 If the removal of doors, panels or shields will expose such moving parts:

- The opening or removal of the door, panel or shield shall require the use of tools; or
- An interlocking device shall shut off the mechanism; or
- A warning marking shall be displayed which reads essentially as follows:

DANGER – TO AVOID INJURY FROM MOVING PARTS, SHUT OFF THE (EQUIPMENT) BEFORE (REMOVING-OPENING) THIS (COVER-DOOR).

5.2.3 The distance from an opening in a required guard or enclosure to the moving part mentioned in 5.2.1 shall be in accordance with Table 5.2, but the minor dimension of the opening shall not in any case exceed 3 inches (76.2 mm). For an opening having a minor dimension intermediate between two of the values included in the table, the distance from the opening to the moving part shall be not less than that found by appropriate interpolation between the corresponding values in the right-hand column of the table. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22 N).

Table 5.2
Dimensions of openings

Minor dimensions of opening		Minimum distance from opening to moving part	
Inches	mm	Inches	mm
1/4	(6.4)	1/2	(12.7)
3/8	(9.5)	1-1/2	(38.1)
1/2	(12.7)	2-1/2	(63.5)
3/4	(19.1)	4-1/2	(114)
1	(25.4)	6-1/2	(165)
1-1/2	(38.1)	10-1/2	(267)
2	(50.8)	14-1/2	(368)
Over 2 inches	(Over 50.8)	30	(762)

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

5.2.4 A moving part is not to be considered when judging compliance with 32.1.2 and 5.2.1 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

6 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 5.1.2 to be factory-assembled.

6.2 The removal of access panels, burners, caps, plugs, and the like 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 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 reduce the risk of it being attached in a manner that may cause unintended 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 result in unintended 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 reduce the risk of distortion or sagging in service. A shield or liner shall be protected against corrosion if its deterioration may cause unintended temperatures 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 reduce the risk of 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.

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, held in place as intended, 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 AISI 1010 hot-rolled sheet steel having a minimum thickness of 0.042 inch (1.07 mm) (No. 18 MSG) unless its deterioration will not cause unintended temperatures 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 its intended 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 maintain the intended damper opening at all times and be arranged to reduce the risk of starting of the burner unless the damper is in the intended 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 Installation of External Controls and Fittings

13.1 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.

13.2 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.

13.3 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.

13.4 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.

13.5 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.

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

13.7 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.

13.8 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.

13.9 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 Field Wiring System Connection

14.1 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be not less than three nor more than five threads in the metal, and the construction of the device shall be such that a conduit bushing can be attached.

14.2 If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall be not less than 3-1/2 threads in the metal and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and which shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

14.3 An enclosure threaded for support by rigid conduit shall provide at least five full threads for engaging with the conduit.

14.4 A knockout in a sheet metal enclosure shall be capable of being removed without undue deformation of the enclosure.

14.5 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing, and shall be so located that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those required.

CONSTRUCTION — ELECTRICAL

15 Controls

15.1 Application

15.1.1 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.

15.1.2 It is the intent of the requirement in 15.1.1 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 15.1.1 may be considered if they accomplish the intent of this requirement.

15.1.3 The requirement of 15.1.1 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.

15.1.4 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.

15.1.5 All safety controls shall be accessible.

15.1.6 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.

15.1.7 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.

15.1.8 A burner not equipped to provide the intended 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.

15.1.9 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 15.1.10 – 15.1.12. See also 15.2.1.

15.1.10 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.

15.1.11 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.

15.1.12 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.

15.1.13 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 37.3.

15.2 Limit control

15.2.1 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 15.2.2 – 15.2.4 and 15.4.1 – 15.5.1. The limit controls shall be in addition to any operating controls specified in 15.1.9 – 15.1.13.

15.2.2 With respect to 15.2.1, 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.

15.2.3 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.

15.2.4 The purpose of the requirement in 15.2.3 is to reduce the risk of interposing in the limit-control circuit and other controls, the failure of which may result in a condition that the limit control is intended to preclude. 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.

15.2.5 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.

15.3 Primary safety control

15.3.1 A field erected boiler assembly shall be provided with a primary safety control to program and monitor the burner operation in accordance with the requirements specified in UL 296, the Standard for Oil Burners; UL 726, the Standard for Oil-Fired Boiler Assemblies; or UL 795, the Standard for Commercial-Industrial Gas-Heating Equipment, as appropriate.

15.4 Liquid level limit controls

15.4.1 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 15.4.2.

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 15.5.1), may employ a water flow sensing device instead of a low water cut-off.

15.4.2 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 gauge).*
- b) *Maximum inside diameter of shell — 16 inches (406.4 mm).*
- c) *Maximum heating surface — 20 square feet (1.86 m²).*
- d) *Gross volume, exclusive of casing and insulation — 5 cubic feet (0.142 m³). See 15.4.3.*

15.4.3 With reference to the exception to 15.4.2, 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.