UL 795

STANDARD FOR SAFETY

Commercial-Industrial Gas Heating Equipment

UL Standard for Safety for Commercial-Industrial Gas Heating Equipment, UL 795

Eighth Edition, Dated December 2, 2016

Summary of Topics

This revision of UL 795 dated September 29, 2020 includes editorial corrections to an equation in paragraph 56.1.5 and a table reference in paragraph 43.2. The revisions published on September 1, 2020 which included changes in requirements for gas vent valve and lines in paragraphs 26.9 and 34.5 are still identified.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 27, 2020 and June 5, 2020.

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1

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

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION – MECHANICAL

CONSTRUCTION – ELECTRICAL

CONSTRUCTION – BURNER ASSEMBLIES

CONSTRUCTION – BOILERS, FURNACES AND HEATERS

PERFORMANCE

OUTDOOR-USE EQUIPMENT

MANUFACTURING AND PRODUCTION TESTS

MARKINGS

INSTRUCTIONS

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements apply to factory-built gas appliances having inputs of more than 400,000 Btu per hour, per individual combustion chamber which require flame failure and other precautions and which are intended primarily for commercial and industrial installation. The appliances covered by these requirements are comfort heating furnaces, heaters and gas-fired boiler assemblies except watertube boilers having outputs of 10,000 pounds of steam per hour or more.

1.2 These requirements also apply to all high pressure steam and high temperature water gas-fired boiler assemblies regardless of Btu per hour input.

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

1.4 Additional installation and operation requirements are available for central-heating gas appliances, floor furnaces, room heaters, unit heaters, and water heaters as defined by the National Fuel Gas Code, NFPA 54, and by the Liquefied Petroleum Gas Code, NFPA 58, as applicable.

2 Glossary

2.1 For the purposes of this Standard the following definitions apply.

2.2 AIR HEATER – An indirect fired vented appliance intended to supply heated air for space heating and other purposes, but not intended for permanent installation.

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

2.4 AIR SHUTTER, AUTOMATICALLY OPERATED – An air shutter operated by an automatic control.

2.5 AIR SHUTTER, MANUALLY OPERATED – An air shutter manually set and locked in the desired position.

2.6 APPLIANCE FLUE – The flue passages within an appliance.

2.7 ALUMINUM COATED STEEL – An aluminum coated steel in which the bond between the steel and the aluminum is an iron-aluminum alloy.

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

2.9 BASE – The main supporting frame or structure of the assembly, exclusive of legs.

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

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

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

2.13 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).

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

2.15 BURNER GAS – A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.

2.16 BURNER, AUTOMATICALLY LIGHTED – One where fuel to the main burner is normally turned on and ignited automatically.

2.17 BURNER, MANUALLY LIGHTED – One where fuel to the main burner is turned on only by hand and ignited under supervision.

2.18 BURNER HEAD, GAS – That portion of a burner beyond the outlet end of the mixer tube which contains the ports.

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

2.20 CHIMNEY CONNECTOR – The pipe which connects a fuel burning appliance to a chimney.

2.21 COMBUSTIBLE MATERIAL – Combustible material, as pertaining to materials adjacent to or in contact with heat producing appliances, chimney connectors and vent connectors, steam and hot water pipes, and warm air ducts, means material made of or surfaced with wood, compressed paper, plant fibers, or other material that will ignite and burn. Such material shall be considered as combustible even though flameproofed, fire retardant treated, or plastered.

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

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

2.24 COMBUSTION DETECTOR – That part of a primary safety control which is responsive directly to flame properties.

2.25 COMBUSTION PRODUCTS – Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inerts, but excluding excess air.

2.26 CONDENSATE – The liquid which separates from a gas, including flue gases, due to a reduction in temperature.

2.27 CONTROL – A device designed to regulate the fuel, air, water, or electrical supply to the controlled equipment. It may be automatic, semi-automatic, or manual.

2.28 CONTROL INPUT, COMBUSTION – A control which automatically regulates the firing rate at predetermined air-fuel ratio in accordance with load demand. It may be a type which positions the air and fuel supplies for low fire and for high fire as required to meet the load demands, or it may be a modulating type which gradually varies the air and fuel supplies within limits to meet the load demand.

2.29 CONTROL, HIGH LIMIT – A protective (safety) control that is responsive to changes in pressure, temperature, liquid level, or flow. It is to be set beyond the intended operating range of the controlled equipment to limit its operation. This control may be electrical or mechanical in nature.

2.30 CONTROL, OPERATING LIMIT – A limit control to start fuel input according to demand and to stop fuel input on satisfaction of demand. An operating limit control may be electrical or mechanical in nature.

2.31 CONTROL, PROTECTIVE (SAFETY) – Automatic controls and interlocks (including relays, switches, and other auxiliary equipment used in conjunction with a safety control circuit) which are intended to prevent operation of the controlled equipment under conditions not anticipated by the design. A control intended to prevent the risk of electric shock, fire, or injury to persons during abnormal operation of the appliance. An example would be a water temperature limit control. A protective control always provides Type 2 action. (See 2.93).

2.32 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 timings, as required, in proper sequence, for purging, flame establishing periods 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.

2.33 DAMPER – A valve or plate for regulating draft or flow of the 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 or vent connector.

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

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

2.36 DIRECT FIRED APPLIANCE – A device in which combustion products (flue gases) are mixed with the medium, e.g., air, being heated.

2.37 DRAFT REGULATOR, BAROMETRIC – A device which functions to maintain a desired draft by automatically reducing the chimney draft to the desired value.

2.38 ELECTRICAL CIRCUITS:

a) High-Voltage Circuit – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.

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

c) Isolated Limited Secondary Circuit – A circuit of limited energy derived from an isolated secondary winding of a transformer having a maximum capacity of 100 volt-amperes (VA) and open-circuit secondary voltage rating not exceeding 1000 volts.

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

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

2.40 FLAME SAFEGUARD – See Control, Primary Safety, 2.31.

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

2.42 FLUE GASES – Combustion products and excess air.

2.43 FURNACE, CENTRAL, WARM AIR – A self-contained indirect fired appliance designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

2.44 FURNACE, FORCED-AIR TYPE, CENTRAL – A central furnace equipped with a fan or blower which provides the primary means for circulation of air.

2.45 FURNACE, DOWNFLOW – A forced-air type central furnace designed with air flow through the furnace essentially in a vertical path, discharging air at or near the bottom of the furnace.

2.46 FURNACE, DUCT – A central furnace designed for installation in a duct of an air distribution system to supply warm air for heating and which depends for air circulation on a blower not furnished as part of the furnace.

2.47 FURNACE, HORIZONTAL – A forced-air type central furnace designed with air flow through the furnace essentially in a horizontal path.

2.48 FURNACE, UPFLOW – A central furnace designed with air flow through the furnace essentially in a vertical path, discharging air at or near the top of the furnace.

2.49 GAS VENT – The piping and fittings for conveying flue gases to the outside atmosphere.

2.50 HEAT EXCHANGER, DIRECT – A heat exchanger in which heat generated in the combustion chamber of the device is transferred direct through walls of the heat exchanger 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-transfer device.

2.51 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. It is an indirect heat-transfer device.

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

2.53 IGNITION, CONTINUOUS – Ignition by an energy source which is continuously maintained through the time the burner is in service, whether the main burner is firing or not.

2.54 IGNITION, INTERMITTENT – Ignition by an energy source which is continuously maintained through the time the burner is firing.

2.55 IGNITION, INTERRUPTED – Ignition by an energy source which is automatically energized each time the main burner is fired and subsequently is automatically shut off during the firing cycle.

2.56 IGNITION, MANUAL – Ignition by an energy source which is manually energized and where the fuel to the pilot is lighted automatically when the ignition system is energized.

2.57 INDIRECT-FIRED DEVICE – A device designed so that combustion products (flue gases) are not mixed in the device with the medium, e.g., air, being heated.

2.58 INTERLOCK – A control to prove the physical state of a required condition, and to furnish that proof to the primary safety control circuit.

2.59 LINER – See Radiation Shield, 2.84.

2.60 LINING – Those interior surfaces of a combustion chamber which are exposed to combustion during use of the device.

2.61 LIQUEFIED-PETROLEUM GAS – Fuel gases, including commercial propane, predominantly propane or propylene or commercial butane, predominantly butane, isobutane, and/or butylene.

2.62 LP-GAS AIR MIXTURE – Liquefied-petroleum gases distributed at relatively low pressures and normal atmospheric temperatures which have been diluted with air to produce desired heating value and utilization characteristic.

2.63 MAIN BURNER FLAME-ESTABLISHING PERIOD – The interval of time the main burner fuel safety shutoff valves are permitted to be open before the primary safety control is required to supervise the main burner flame.

2.64 MANIFOLD – The conduit of a device which supplies gas to the individual burner.

2.65 MIXER, GAS – The combination of mixer head, mixer throat, and mixer tube.

a) Mixer Head – That portion of an injection type burner, usually enlarged, into which primary air flows to mix with the gas stream.

b) Mixer Throat – That portion of the mixer which has the smallest cross-sectional area and which lies between the mixer head and the mixer tube.

c) Mixer Tube – That portion of the mixer which lies between the throat and the burner head.

2.66 MIXER FACE, GAS – The air inlet end of the mixer head.

2.67 NORMAL CARE – The periodic tasks usually performed to operate and maintain an appliance, such as air, fuel, pressure, and temperature regulation, cleaning, lubrication, and resetting of controls.

2.68 ORIFICE – The opening in a cap, spud, or other device whereby the flow of gas is limited and through which the gas is discharged to a burner.

2.69 ORIFICE CAP (HOOD) – A movable fitting having an orifice which permits adjustment of the flow of gas by the changing of its position with respect to a fixed needle or other device.

2.70 ORIFICE SPUD – A removable plug or cap containing an orifice and which permits adjustment of the flow of gas either by substitution of a spud with a different sized orifice or by the motion of a needle with respect to it.

2.71 PILOT, CONTINUOUS – A pilot that burns without turn-down throughout the entire time the burner assembly is in service, whether the main burner is firing or not.

2.72 PILOT, EXPANDING – A pilot that burns throughout the entire time the burner assembly is in service, whether the main burner is firing or not. Upon a call for heat, the pilot is automatically expanded so as to reliably ignite the main burner. This pilot may be turned down automatically at the end of main burner flame-establishing period.

2.73 PILOT FLAME-ESTABLISHING PERIOD – The interval of time fuel is permitted to be delivered to a proved pilot before the primary safety control is required to detect pilot flame.

2.74 PILOT, INTERMITTENT – A pilot which is automatically lighted each time there is a call for heat, if burns during the entire period that the main burner is firing.

2.75 PILOT, INTERRUPTED – A pilot which is automatically lighted each time there is a call for heat. The pilot fuel is cut off automatically at the end of the main burner flame-establishing period.

2.76 PILOT, PROVED – A pilot flame supervised by a primary safety control.

2.77 PLENUM – An air compartment, part of a distributing system, to which one or more ducts are connected.

a) Furnace Supply Plenum – A furnace plenum attached directly to, or an integral part of, the supply outlet of the furnace.

b) Furnace Return Plenum – A furnace plenum attached directly to, or an integral part of, the return air inlet of the furnace.

2.78 PORT – Any opening in a burner head through which fuel or an air-fuel mixture is discharged for ignition.

2.79 PRESSURE CUT-OUT – A pressure sensing control intended to keep a pressure below or above one particular value during abnormal operating conditions and which has no provisions for setting by the user.

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

2.81 POST-PURGE 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.

2.82 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.

2.83 PROOF OF CLOSURE SWITCH – A non-field adjustable switch installed in a safety shutoff valve by its manufacturer that activates only after the valve is fully closed.

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

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

2.86 REGULATOR, GAS-PRESSURE – A device for controlling and maintaining a uniform outlet gas pressure.

2.87 RESPONSE TIME – FLAME FAILURE – The interval between the occurrence of flame extinguishment and de-energizing the safety shutoff means.

2.88 SAFETY CONTROL – See Control, Safety, 2.31.

2.89 SAFETY SHUTDOWN – The action of shutting off all fuel and ignition energy to the device by means of a safety control or controls such that restart cannot be accomplished without manual reset.

2.90 SECONDARY AIR – The air externally supplied to the flame at the point of combustion.

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

2.92 TOOLS, SPECIAL – Those tools that are not available on the open retail market.

2.93 TYPE 2 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.94 UNIT HEATER:

a) Low-Static Pressure Type – A self-contained, automatically controlled, vented fuel burning device having integral means for circulation of air, normally by a propeller fan (or fans). Such devices may be equipped with louvers or face extensions made in accordance with the manufacturer's approved specifications.

b) High-Static Pressure Type – A self-contained, automatically controlled, vented fuel burning device having integral means for circulation of air against 0.2 inch or greater static pressure and designed for installation in the space to be heated unless they are equipped with provisions for attaching both inlet and outlet air ducts.

2.95 VALVE, BURNER-INPUT CONTROL – An automatic-control valve for regulating the input of fuel to a burner.

2.96 VALVE, SAFETY SHUTOFF – A valve that is automatically closed by the safety control system or by an emergency device. Such valve may be of the automatic or manually opened type.

2.97 VALVE, LUBRICATED PLUG TYPE – A valve of the plug and barrel type designed for maintaining a lubricant between the bearing surfaces.

2.98 VALVE, MANUAL GAS SHUTOFF – A manually operated valve in a gas line for the purpose of completely turning on or shutting off the gas supply.

2.99 VENT CONNECTOR – The pipe which connects a gas-fired device to a gas vent or chimney.

2.100 ZERO GOVERNOR – A regulating device which is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

3 Units of Measurement

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

4 Undated References

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

5 Components

5.1 Except as indicated in 5.2, a component of a product covered by this standard shall comply with the requirements for that component. See the individual sections of this Standard for component requirements.

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

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

b) Is superseded by a requirement in this standard.

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

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

CONSTRUCTION – MECHANICAL

6 General

6.1 The requirements of 23.1 are not applicable to mechanical service functions which are not normally performed with the equipment energized.

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

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

a) The opening or removal of the door, panel or shield shall require the use of tools; or

b) An interlocking device shall shut off the mechanism; or

c) 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).

6.4 The distance from an opening in a required guard or enclosure to the moving part mentioned in 6.3 shall be in accordance with the following table, 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.

Minor dimensions of opening, inches[a]	Minimum distance from opening to moving part, inches
1/4	1/2
3/8	1-1/2
1/2	2-1/2
3/4	4-1/2
1	6-1/2
1-1/2	10-1/2
2	14-1/2
Over 2	30

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

6.5 A moving part is not to be considered when judging compliance with 6.3 and 6.4 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

6.6 Parts that may come in contact with the operator's hand during normal adjustment or servicing shall be free from sharp projections or edges and projecting screw ends.

7 Corrosion Protection

7.1 Iron and steel parts shall be protected against corrosion by painting, galvanizing, plating or other equivalent means when malfunctioning of such unprotected part results in a hazardous condition.

Exception: Cast-iron parts, cast-aluminum parts and ASME coded pressure vessels are not required to be protected against corrosion.

7.2 Surfaces of the burner assembly and flue gas conveying parts that contact flue gas condensation shall be evaluated with respect to resistance to corrosion. Among the factors to be considered are material thickness and type, length of time subjected to the condensate condition and type of corrosion protection provided. See 50.4.

8 General Components and Devices

8.1 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

8.2 Thermoplastic wiring material shall comply with the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

8.3 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62.

8.4 Fittings for conduit and/or metal clad cable shall comply with the Standard for Conduit, Tubing, Cable Fittings, UL 514B.

8.5 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9 for Class K).

8.6 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable UL 248 Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another applicable UL standard for fuses are considered to comply with this requirement.

8.7 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

8.8 Terminal Blocks shall comply with the Standard for Terminal Blocks, UL 1059.

8.9 Electrical (Junction) boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A or the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, as applicable.

8.10 Attachment-plug receptacles intended for general use as a convenience receptacle on the equipment shall be of the grounding type, and shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

CONSTRUCTION – ELECTRICAL

9 General

9.1 Fuel confining parts, or operating parts if failure of the part will allow excess leakage of fuel, unintended operation, or restrict a safety device from functioning, shall be of sufficient strength, durability, and resistance to fire. Such parts shall be made of material having a melting point (solidus temperature) of not less than 950°F (510°C) and a tensile strength of not less than 10,000 psi at 400°F (204°C). Such parts shall not sag, distort, melt, oxidize, or show leakage of fuel during any of the tests specified herein.

9.2 Electrical equipment and wiring shall be arranged so that oil or water will not drip or run on them during normal usage or from a connection required to be uncoupled for servicing the device also to reduce the risk of contact with water from humidifiers.

9.3 Attachment plugs or separable connectors shall not be used in circuits when the breaking or making of the circuit by such devices may result in operation of the equipment in a manner that involves a risk of fire, electric shock, or injury to persons.

10 Servicing and Adjustment

10.1 Service functions which may have to be performed with the equipment energized include:

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

b) Resetting control trip mechanism; operating manual switches;

c) Adjusting air-flow dampers.

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

10.2 Adjustable or resettable electrical control or manual switching devices may be located or oriented with respect to uninsulated live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the normal direction of access if uninsulated live parts or moving parts are:

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

b) Are not located within 6 inches on any side or behind the mechanism, unless guarded.

10.3 An electrical control component which may require examination, adjustment, servicing, or maintenance while energized, not including voltage measurements, shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical service functions without subjecting the serviceman to the likelihood of risk of electric shock from adjacent uninsulated live parts or to the risk of injury from adjacent moving parts.

10.4 Components in a low-voltage circuit are to comply with the requirements of 10.3 in their relation to uninsulated live parts in a high-voltage circuit and to moving parts.

11 Electrical Enclosures

11.1 Uninsulated high-voltage parts shall be enclosed or guarded to reduce the likelihood of unintentional contact by persons during normal use of the equipment. This applies also to such parts located in a compartment into which access is required for normal care of the equipment, such as resetting controls, replacing filters, lubrication, cleaning, and the like.

11.2 Sheet metal complying with Table 11.1 and Table 11.2 whichever applies, meets the requirement for the individual enclosure of electrical components.

Table 11.1
Minimum thickness of sheet metal for enclosures carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness in inches (mm)			
Maximum width[b] in inches (cm)		Maximum length[c] in inches (cm)		Maximum width[b] in inches (cm)		Maximum length in inches (cm)		Uncoated (MSG)		Metal coated (GSG)	
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020[d]	(0.51)	0.023[d]	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)	(24)		(24)	
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026[d]	(0.66)	0.029[d]	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)	(22)		(22)	
8.0	(20.4)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	(20)		(20)	
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)	(18)		(18)	
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.34)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)	(16)		(16)	
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.53)	0.063	(1.61)
25.0	(63.5)	31.0	(78.7)	35.0	(89.0)	43.0	(109.2)	(15)		(15)	
25.0	(63.4)	Not limited		39.0	(99.1)	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)	(14)		(14)	
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.04)	0.084	(2.13)
35.0	(89.0)	47.0	(119.4)	54.0	(137.1)	66.0	(167.6)	(13)		(13)	
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	(12)		(12)	
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.80)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	(11)		(11)	
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	0.126

Table 11.1 Continued on Next Page

Table 11.1 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness in inches (mm)		
Maximum width[b] in inches (cm)		Maximum length[c] in inches (cm)		Maximum width[b] in inches (cm)		Maximum length in inches (cm)		Uncoated (MSG)	Metal coated (GSG)	
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	(10)	(10)	(3.20)

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

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

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

3) An enclosure surface loosely attached to a frame, e.g. with spring clips.

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

[c] For panels which are not supported along one side, e.g., side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

[d] Sheet metal for an enclosure intended for outdoor use shall comply with 60.7 and 60.8.

Table 11.2
Minimum thickness of sheet metal for enclosures aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness inches (mm) (AWG)	
Maximum width[b] in inches (cm)		Maximum length[c] in inches (cm)		Maximum width[b] in inches (cm)		Maximum length in inches (cm)			
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023[d]	(22)
3.5	(8.9)	4.0	(10.2)	8.5	(21.7)	9.5	(24.1)	(0.58)	
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029	(20)
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.2)	(0.74)	
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036	(18)
6.5	(16.5)	8.0	(20.4)	15.0	(38.1)	18.0	(45.7)	(0.91)	
8.0	(20.4)	Not limited		19.0	(48.3)	Not limited		0.045	(16)
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	(1.14)	
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058	(14)
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	(1.47)	
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075	(12)
20.0	(50.8)	25.0	(63.4)	45.0	(114.3)	55.0	(139.7)	(1.91)	
25.0	(63.4)	Not limited		60.0	(152.4)	Not limited		0.095	(10)
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)	(2.41)	
37.0	(94.0)	Not limited		87.0	(221.9)	Not limited		0.122	(8)
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)	(3.10)	
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited		0.153	(6)
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)	(3.89)	

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending

Table 11.2 Continued on Next Page

Table 11.2 Continued

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]		
Maximum width[b] in inches (cm)	Maximum length[c] in inches (cm)	Maximum width[b] in inches (cm)	Maximum length in inches (cm)	Minimum thickness inches (mm) (AWG)
moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes: 1) Single sheet with single formed flanges (formed edges), 2) A single sheet which is corrugated or ribbed, and 3) An enclosure surface loosely attached to a frame, e.g. with spring clips. [b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet. [c] For panels which are not supported along one side, e.g., side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide. [d] Sheet metal for an enclosure intended for outdoor use shall comply with 60.7 and 60.8.				

11.3 Among the factors taken into consideration when evaluating an enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture absorptive properties;

d) Combustibility;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use.

For a nonmetallic enclosure or part of an enclosure, all these factors are considered with respect to thermal and chemical aging according to the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. An enclosure complying with the requirements of the Standard for Industrial Control Panels, UL 508A, would be considered to comply with the requirements of (a) – (f).

11.4 Where the design and location of the component and the strength and rigidity of the outer cabinet warrant, an individual enclosure of thinner metal than specified in Table 11.1 or Table 11.2 whichever applies, may be employed.

11.5 Electrical parts within the outer cabinet need not be individually enclosed if the assembly conforms with all of the following:

a) Their design and location with respect to openings in the outer cabinet will not result in the emission of flame or molten metal through openings in the cabinet or if it can be shown that failure of the component would not result in a risk of fire.

b) There are no openings in the bottom of the compartment in which the part is located which would permit dropping of molten metal, and the like, onto combustible material.

c) The part is not in proximity to combustible material other than electrical insulation.