UL 2790

STANDARD FOR SAFETY

Commercial Incinerators

UL Standard for Safety for Commercial Incinerators, UL 2790

First Edition, Dated November 8, 2010

Summary of Topics

This revision to ANSI/UL 2790 dated April 2, 2024 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated February 16, 2024.

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UL 2790

Standard for Commercial Incinerators

Prior to the first edition, the requirements for the products covered by this standard were included in the Outline of Investigation for Commercial Incinerators, SU 2790.

First Edition

November 8, 2010

This ANSI/UL Standard for Safety consists of the First Edition including revisions through April 2, 2024.

The most recent designation of ANSI/UL 2790 as a Reaffirmed American National Standard (ANS) occurred on April 2, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements apply to direct-fed incinerators, including those of the gas and electric ignition types, designed primarily for use as a crematory (as defined in 5.30). They are not intended to incinerate any hazardous, including biological/infectious, chemical and/or explosive, types of material and not intended for use in spaces in which flammable vapor or gases may be present.

1.2 These requirements are only intended to cover the safety aspect of the direct-fed incinerators, with respect to fire, shock, mechanical hazards, and carbon monoxide emissions.

1.3 Crematories covered by these requirements are the factory-made type and may be field assembled. These requirements do not cover an incinerator that requires the use of a brick or masonry wall, etc., which forms a part of the building structure.

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

1.5 Incinerators may be subject to local regulations and/or EPA regulations, such as the Clean Air Act and/or the Resource Conservation and Recovery Act, with respect to:

a) Particulate emissions, oxides of nitrogen, and other products of combustion in the flue gas. These requirements do not include limitations on Nox emissions and only carbon monoxide was required to be within the specified limits.

b) The types of wastes to be incinerated.

1.6 Additional installation and operation requirements are available as defined by the National Fuel Gas Code, NFPA 54, the Liquefied Petroleum Gas Code, NFPA 58, the National Electrical Code, NFPA 70 and other codes as applicable.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 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.

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

2.4 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.

3 Units of Measurement

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

3.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are rms.

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 Glossary

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

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

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

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

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

5.6 ASH – The solid residue remaining after combustion or incineration has been completed.

5.7 ASH PIT DOOR – A door below the grate level used for removing ash or other noncombustibles from the incinerator.

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

5.9 BASE – The main supporting frame or structure of the assembly.

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

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

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

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

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

5.15 CHIMNEY, HIGH-HEAT – A chimney capable of withstanding a continuous flue gas temperature exceeding 982°C (1800°F).

5.16 CHIMNEY, MEDIUM-HEAT – A chimney capable of withstanding a continuous flue gas temperature not exceeding 982°C (1800°F).

5.17 CHIMNEY CONNECTOR – The pipe which connects a fuel burning incinerator to a chimney.

5.18 CHIMNEY, FACTORY BUILT – Those chimneys of the factory-made type intended for use with gas fired incinerators.

5.19 COMBUSTIBLE MATERIAL – Combustible material, as pertaining to materials adjacent to or in contact with heat producing incinerators, chimney connectors and vent connectors, 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.

5.20 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.

5.21 COMBUSTION CHAMBER – The portion of an incinerator within which combustion occurs.

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

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

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

5.25 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.

5.26 CONTROL, LIMIT – A safety (protective) control that is responsive to changes in pressure, temperature or flow. This control may be used for regulating purposes or may be set beyond the intended operating range of the controlled equipment to limit its operation. This control may be electrical or mechanical in nature.

5.27 CONTROL, OPERATING – A control to start or regulate burner firing according to load demand and to stop or regulate firing of the burner on satisfaction of demand or upon reaching normal temperature or pressure in the incinerator being fired. An operating control may be electrical or mechanical in nature and may actuate auxiliary devices to perform the functions described above. An operating control could provide Type 1 or Type 2 action. (See 5.76 and 5.77.)

5.28 CONTROL, SAFETY (PROTECTIVE) – 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 high gas pressure limit control. A protective control always provides Type 2 action. (See 5.76 and 5.77.)

5.29 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.

5.30 CREMATORY – An incinerator, for commercial purposes, used to reduce to ash animal and human cadavers. It is intended to be factory-made and can be installed as a packaged unit or assembled in the field from factory built subassemblies.

5.31 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 in which failure due to grounding, opening, or shorting of any part of the circuit can cause unsafe operation of the controlled incinerator or can introduce a direct fire or life hazard.

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

5.33 FLAME SAFEGUARD – See Control, Primary Safety, 5.29.

5.34 FLUE – A conduit or passageway, vertical or nearly so, for conveying flue gases to the outer air.

5.35 FLUE COLLAR – That portion of an incinerator designed for attachment of the chimney, flue or vent connector.

5.36 FLUE GASES – Combustion products and excess air.

5.37 FLUE PIPE – The conduit connecting the incinerator with the chimney.

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

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

5.40 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.

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

5.42 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.

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

5.44 LINER – See Radiation Shield, 5.69.

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

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

5.47 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.

5.48 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.

5.49 MANIFOLD – The conduit of an incinerator which supplies gas to the individual burner.

5.50 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.

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

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

5.53 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.

5.54 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.

5.55 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.

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

5.57 PILOT, AUTOMATIC – Consists of an automatic pilot device and pilot burner assembly securely assembled in fixed functional relationship.

5.58 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.

5.59 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.

5.60 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.

5.61 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.

5.62 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.

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

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

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

5.66 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.

5.67 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.

5.68 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.

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

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

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

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

5.73 SAFETY CONTROL – See Control, Safety, 5.28.

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

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

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

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

5.78 TYPE 1 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have not been declared and tested to the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

5.79 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 for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

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

5.81 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.

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

5.83 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.

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

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

CONSTRUCTION – ELECTRICAL

6 General

6.1 Electrical devices 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 incinerator.

6.2 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 incinerator in a manner that involves a risk of fire, electric shock, or injury to persons.

7 Servicing and Adjustment

7.1 Service functions which may have to be performed with the incinerator 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.

7.2 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 (152 mm) on any side or behind the mechanism, unless guarded.

7.3 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.

7.4 Components in a low-voltage circuit are to comply with the requirements of 21.3 in their relation to uninsulated live parts in a high-voltage circuit and to moving parts.

8 Enclosures

8.1 General

8.1.1 Uninsulated live high-voltage parts shall be enclosed or guarded to prevent unintentional contact by persons during normal use of the appliance. This applies to such parts located in a compartment where access is required for normal care of the appliance, such as resetting controls, replacing filters, lubrication, cleaning, and the like.

8.1.2 Among the factors taken into consideration when judging the acceptability of 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 Material – Use in Electrical Equipment Evaluations, UL 746C.

8.1.3 The enclosure shall reduce the likelihood of the emission of molten metal, burning insulation, flaming particles, or the like through openings onto combustible material, including the surface on which the equipment is mounted.

8.1.4 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 8.1 or Table 8.2 whichever applies, may be employed.

8.1.5 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;

d) The part is not located closer than 5 inches (127 mm) to the outer cabinet unless the thickness of sheet metal is in compliance with Table 8.1;

e) The part is not located in an air-handling compartment;

f) The thickness of the outer cabinet is not less than two-gage thicknesses thinner than indicated in Table 8.1 for the maximum dimensions of the cabinet enclosure.

g) The part is not subject to unintentional contact by persons. See 22.8 – 22.17.

8.1.6 The requirements of 8.1.5 apply only to parts of high-voltage circuits as defined by these requirements.

8.1.7 All intended mounting positions of the unit are to be considered when determining if it complies with the requirement of 8.1.3.

8.1.8 Cabinet compartments housing gas piping and controls shall be ventilated.

8.1.9 Steel enclosures shall be protected against corrosion by painting, plating, or equivalent means.

8.1.10 The thickness of a sheet metal enclosure shall be as indicated in Table 8.1 and Table 8.2.

Exception: When the design and location of components and the strength and rigidity of the outer cabinet warrant, an individual enclosure thinner than specified in Table 8.1 and Table 8.2 is able to be employed.

Table 8.1
Minimum thickness of sheet metal for enclosures – carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing				Minimum thickness, inches (mm)			
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length		Uncoated		Metal coated	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(MSG)		(GSG)	
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020	(0.51)	0.023	(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	(0.66)	0.029	(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		0.32	(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		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	(104.0)	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)
42.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	(12)		(12)	
52.0	(135.1)	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	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	(10)		(10)	

[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 a 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, for example, 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 lifted to the dimensions specified unless the side in question is provided with a flange at lease 1/2 inch (12.7 mm) wide.

Table 8.2
Minimum thickness of sheet metal for enclosures – aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness	
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length			
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(mm)	(AWG)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023	(0.58)
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)		(22)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029	(0.74)
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)		(20)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036	(0.91)
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)		(18)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045	(1.14)
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)		(16)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058	(1.47)
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)		(14)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075	(1.91)
20.0	(50.8)	25.0	(63.4)	45.0	(114.3)	55.0	(139.7)		(12)
25.0	(63.4)	Not limited		60.0	(152.4)	Not limited		0.095	(2.41)
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)		(10)
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited		0.122	(3.10)
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)		(8)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited		0.153	(3.89)
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)		(6)

[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, such as, 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, for example, 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 lease 1/2 inch (12.7 mm) wide.

8.1.11 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) (No. 20 MSG) if uncoated steel, not less than 0.034 inch (0.86 mm) (No. 20 GSG) if galvanized steel, and not less than 0.045 inch (1.14 mm) if nonferrous.

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

8.1.13 Terminal housings of motors, to which connections are to be made in the field, shall be of metal and shall be sized in accordance with the National Electrical Code, NFPA 70.

8.1.14 A junction box partially formed by another part such as a fan scroll or a motor casing is to fit such that:

a) An opening between the box and motor frame having a dimension exceeding 1/2 inch (12.7 mm) does not permit a flat feeler gauge, 5/64 by 1/2 inch (2.0 by 12.7 mm) wide to enter; and

b) An opening between the box and motor frame having no dimension exceeding 1/2 inch (12.7 mm) does not permit the entrance of a 13/64 inch (5.2 mm) diameter rod.

8.1.15 The criteria for judging an opening in an electrical enclosure are given in the following items and the related figures:

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

1) A probe, as illustrated in Figure 8.1, cannot be made to touch any uninsulated live part when inserted through the opening; and

2) A probe, as illustrated in Figure 8.1, cannot be made to touch enamel insulated wire when inserted through the opening.

b) An opening that will permit entrance of a 3/4 inch diameter rod is acceptable under the conditions described in Doors and covers, 8.3.

8.1.16 During the examination for conformance with the requirements in 8.1.15, a part of the enclosure, which may be removed with the use of tools is to be removed.

8.2 Accessibility of uninsulated live parts and film-coated wire – general

8.2.1 During the examination of a product to determine whether it complies with the requirements concerning accessibility of uninsulated live parts and film-coated wire:

a) A part of the enclosure that may be opened or removed by the user without using a tool, (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed;

b) Insulated brush caps are not required to be additionally enclosed;

c) The probes shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure; and

d) The probes shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

8.2.2 The criteria for judging an opening in an electrical enclosure are given in (a) – (b) and the related figures:

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

1) A probe as illustrated in Figure 8.1 cannot be made to touch any uninsulated live part when inserted through the opening; and

2) A probe as illustrated in Figure 8.2 cannot be made to touch film-coated wire when inserted through the opening.