UL 724

Outline of Investigation for Indirect Fired, Oil Burning Commercial Cooking Appliances

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Summary of Topics

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INTRODUCTION

1 Scope

1.1 These requirements cover indirect fired oil-burning floor-supported food service equipment equipped with an oil burner providing coverage for griddles, baking and roasting ovens, deep fat fryers, and kettles, hereinafter referred to as “appliances,” constructed entirely of new, unused parts and materials for use in food service centers of commercial, industrial, institutional and public assembly buildings.

1.2 These requirements cover appliances intended to burn standard Grades No. 1 and 2 fuel oils as specified in the Specification for Fuel Oils, ASTM D396, and standard Grades No. 1 and 2 diesel fuels as specified in the Specification for Diesel Fuel Oils, ASTM D975.

1.3 The oil-burning equipment covered by these requirements are intended for installation in accordance with the National Fire Protection Association Standard for Installation of Oil-Burning Equipment, NFPA 31, the International Mechanical Code, and the Uniform Mechanical Code.

1.4 Appliances generating steam, at pressures above atmospheric, for cooking purposes are not covered by these requirements.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this outline shall comply with the requirements for that component. See the individual sections of this Outline of Investigation for component requirements.

2.2 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 outline, or

b) Is superseded by a requirement in this outline.

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.

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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 outline shall be interpreted as referring to the latest edition of that code or standard.

5 Glossary

5.1 For the purpose 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 and/or secondary air.

5.3 APPLIANCE – Refers to any equipment covered by these requirements unless specifically noted otherwise.

5.4 APPLIANCE FLUE – The flue passages within the appliance.

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

5.6 BASE – The lowest supporting frame or structure of the appliance, exclusive of legs.

5.7 BODY – The principal structure of the appliance, including the supporting frame, which gives strength and rigidity to the appliance.

5.8 BURNER BOX – The surfaces immediately surrounding a burner.

5.9 BURNER, MECHANICAL-ATOMIZING TYPE – A power-operated burner that prepares and delivers the oil and all or part of the air by mechanical process in controllable quantities for combustion. Some examples are air and steam atomizing, high and low pressure atomizing, burners.

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

5.11 COMBUSTIBLE MATERIAL – Combustible material as pertaining to materials adjacent to or in contact with heat-producing appliances, chimney connectors and vent connectors, 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 though flameproofed, fire-retardant treated, or plastered.

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

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5.13 CONTROL, LIMIT – As it pertains to this standard, a safety control responsive to changes in temperature normally set beyond the intended operating range of the appliance to limit its operation.

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

5.15 CONTROL, SAFETY – Automatic controls, including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety control system, that are intended to reduce the risk of improper operation of the appliance.

5.16 CONTROL, SAFETY COMBUSTION – See Control, Primary Safety.

5.17 COOKING VESSEL – The liquid container in which the cooking process is conducted.

5.18 DEEP FAT FRYER, FOOD SERVICE – An appliance including a cooking vessel in which oils or fats are placed to such a depth that the cooking food is essentially supported by displacement of the cooking fluid or a perforated container immersed in the cooking fluid rather than by the bottom of the vessel. For the purpose of this standard, a deep fat fryer shall be limited to a capacity of 300 lb or less of cooking oil as determined by the manufacturer's rating, and shall be designed primarily for use in hotels, restaurants, clubs and similar institutions.

5.19 DRAFT REGULATOR, BAROMETRIC (AUTOMATIC DAMPER) – A device that functions to maintain a desired draft in the appliance by automatically reducing excess chimney draft to the desired value.

5.20 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 rms alternating-current (42.4 volts peak) or direct current and supplied by:

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

2) Is limited to a maximum of 100 volt-amperes.

A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

c) 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 and open-circuit secondary voltage rating not exceeding 1000 volts.

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

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5.21 ELECTRICAL ENCLOSURE – The part of the appliance that surrounds insulated and uninsulated current-carrying live parts and that is intended to contain a fire resulting from an electrical fault.

5.22 GRIDDLE – An appliance having a cooking surface which transfers heat directly to a food product through convection or conduction.

5.23 INDIRECT-FIRED APPLIANCE – An appliance constructed so that combustion products or flue gases are not mixed in the appliance with the medium, that is, to be heated; hence is provided with a flue collar.

5.24 INDIRECT OVEN THERMOSTAT SYSTEM – A control system of two or more integrated automatic devices to maintain an oven temperature as selected by the operator. That portion of the system responsive to oven temperature causes operation of another portion of the system to turn on or shut off the oil supply to the oven burner.

5.25 INTENDED OPERATION – Normal operation of the appliance where the fire, shock, and mechanical hazards are mitigated.

5.26 KETTLE – An appliance with a cooking chamber which is heated either by a steam jacket in which steam is generated by fuel heat or by direct fuel heat applied to the cooking chamber.

5.27 NON-COMBUSTIBLE MATERIAL – Non-combustible material as pertaining to materials adjacent to or in contact with heat-producing appliances, chimney connectors and vent connectors, refers to materials that will not ignite and burn.

5.28 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. Repair and replacement of parts other than those expected to be renewed periodically is not considered to be servicing. Some examples of servicing are:

a) Cleaning or replacing nozzles, atomizers, and pilots.

b) Setting ignition electrodes.

c) Cleaning strainers or replacing strainer or filter element.

d) Resetting safety control.

e) Replacing igniter cable.

5.29 OVEN, BAKING AND ROASTING – An oven primarily intended for volume food preparation which can be composed of one or more sections or units of the following types:

a) Cabinet Oven. An oven having one or more cavities heated by a single burner or group of burners.

b) Reel-Type Oven. An oven employing trays that are moved by mechanical means.

c) Sectional Oven. An oven composed of one or more independently heated cavities.

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5.30 OVEN, INDIRECT – An enclosed compartment in which cooking is accomplished primarily by convected heat in which the flue gases do not flow through the oven compartment.

5.31 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.

5.32 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.

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

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

5.35 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.

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

5.37 SERVICING – See Normal Care.

5.38 SPECIAL TOOLS – Those tools which are not available on the open retail market.

5.39 STEAM COOKER – A fuel-fired appliance which cooks, defrosts or reconstitutes food by direct contact with steam (at atmospheric pressure).

5.40 THERMOSTAT – A device which senses changes in temperature and controls electrically, by means of separate components, the flow of fuel to the burner(s) to maintain selected temperatures.

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

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

a) Metering (Regulating) Valve – An oil control valve for regulating burner input.

b) Safety Valve – A normally closed valve of the ″on″ and ″off″ type, without any bypass to the burner, that is actuated by a safety control or by an emergency device.

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

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CONSTRUCTION – MECHANICAL

6 Assembly

6.1 An appliance shall be factory-built as a group assembly and shall include all the essential components necessary for its intended function when installed as intended. An oil-burning appliance may be shipped as two or more major subassemblies. The oil burner shall comply with the Standard for Oil Burners, UL 296.

6.2 An appliance, if not assembled by the manufacturer as a unit, shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated into the final assembly without requiring alteration, cutting, drilling (except to the extent indicated in 6.3), threading, welding, or similar tasks by the installer. Two or more subassemblies, that must bear a definite relationship to each other for the intended installation or operation of the appliance, 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.

6.3 To be in accordance with 6.2, major subassemblies of an appliance are deemed to be:

a) The burner and safety controls;

b) The cooking element, including its base, combustion chamber, and casing.

A wiring harness may be packaged with one of the major subassemblies.

6.4 An appliance shall provide for convenient operation of those parts requiring attention or manipulation by the user during intended usage.

6.5 Adjustable or movable parts shall be provided with locking devices to reduce the risk of unintentional shifting. Lock nuts or adjusting nuts held by springs or compression will be considered satisfactory except where their adjustment can be accidentally disturbed.

6.6 The construction of all parts, whether specifically covered by the various sections of this standard or not, shall be in accordance with reasonable concepts of safety, substantiality and durability. All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

6.7 Asbestos shall not be used in the construction of an appliance.

6.8 Components such as grease extractors and fire extinguisher systems, which are supplied as a part of the appliance, shall comply with nationally recognized standards.

6.9 The general construction and assembly shall be neat with parts well fitted and bolts or other fasteners drawn up tightly to give rigidity. Exposed edges which might be brought in contact with the hand during usage or adjustment shall be smooth.

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6.10 Materials used in the construction of the appliance shall be suitable for the temperatures to which they will be exposed during the course of testing under this standard.

6.11 Except as specified in 6.12, burners, thermostats, door springs, electrical components and other accessories and controls which may require servicing or replacement shall be readily accessible from the front of the appliance without disconnecting the appliance from the fuel supply. Special tools shall not be required for making adjustments. The removal of a panel or opening a door when the appliance is in a normally installed position is permissible.

6.12 An appliance equipped with casters may be designed so servicing can be accomplished when the appliance is removed from its installed position marked in accordance with 62.20 and the instruction manual contains the information specified in 63.3 (k) and (l). Fuel-air adjustments, if provided, must be capable of being made with the appliance in its installed position.

6.13 Every part of the appliance shall be of such construction as to be secure against displacement, distortion, warping or other damage and shall be supported to maintain a fixed relationship between essential parts. Such parts not permanently secured shall be designed so that they cannot be incorrectly assembled and cannot be improperly located or misaligned in removing or replacing during cleaning or other servicing. If any indication is observed during the tests prescribed herein that the appliance will not continue to meet this standard in normal usage, supplementary tests shall be conducted to determine compliance with this standard. In submitting an appliance for test, the manufacturer may furnish a list of manufacturing tolerances applicable thereto and may have the appliance tested for compliance with this standard in both extremes of tolerances specified.

6.14 Construction shall be such that primary air adjustments can be made with the burner in place and in operation. On a built-in unit, it shall be possible to perform this manipulation and make the necessary electrical supply connections at the appliance from the front of the installed appliance.

6.15 Clearance shall be provided to afford manipulation of standard tools when connecting the appliance to supply piping.

6.16 By direct or indirect means it shall be possible to ascertain whether each electrical control component is functioning without disassembly of the appliance to a degree which would render it inoperative. If electrically live parts are exposed in making any adjustments, an access panel shall be provided which requires the use of tools for its removal. Means shall be provided for normal cleaning of the appliance and for changing fuses and lamps without exposing electrically live parts except screw shells or clips of lamp holders and fuse holders. Partial disassembly for this purpose is permissible provided wiring is not exposed in such a manner as to be possibly damaged or have strain applied to connections during servicing.

6.17 Materials used in the construction of these appliances shall be suitable for temperatures to which they will be exposed during the course of testing under this standard.

6.18 If operation of the appliance is necessary to make adjustments, making the adjustment shall be possible without exposing electrically live parts, disturbing wiring, and without the necessity of manipulating tools within any burner compartment.

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6.19 Griddles shall be designed so that grease is drained to an accessible part of the appliance where it may be readily removed.

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

Table 6.1
Maximum torque requirements for screw or bolts

American standard screw size		Torque		I.S.O. screw size	Torque	
No.	**mm**	**Lb-in.**	**Nm**	**mm**	**Nm**	**Lb-in.**
–	–	–	–	4	1.6	14
8	4.2	18	2.0	4.5	2.6	23
10	4.8	30	3.4	5	4.2	37
Inch	**mm**					
1/4	6.4	100	11.3	6	8.7	77
–	–	–	–	7	15.0	133
5/16	7.9	200	22.6	8	23.5	208
–	–	–	–	9	33.6	297
3/8	9.5	350	39.6	10	45.2	400
7/16	11.1	575	65.0	12	81.0	715
1/2	12.7	850	96.0	14	128.0	1130
9/16	14.3	1200	136.0	–	–	–
5/8	15.9	1600	181.0	16	185.0	1640

6.21 Any external door providing access into the combustion chamber of an appliance intended for installation with a clearance of less than 24 inches (610 mm) from the face of or 48 inches (1220 mm) above the door shall be self-closing.

6.22 An appliance shall conform to the following:

a) All interior surfaces of the heat exchanger, combustion chamber including its bottom, radiators, and flues shall be resistant to corrosion by moisture.

b) The firebox liner shall resist deterioration from being wetted by condensation.

c) Condensation shall not drip on burner parts or other corrodible parts if corrosion of any such parts may cause operation that may result in a risk of fire, electric shock, or injury to persons.

d) The heat exchanger and appliance flue shall contain no traps or pockets in which condensation may collect.

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

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6.24 Fuel oil pumps provided as part of the burner shall comply with the Standard for Pumps for Oil Burning Appliances, UL 343.

6.25 Strainers supplied with the appliance shall comply with the requirements of the Standard for Strainers for Flammable Fluids and Anhydrous Ammonia, UL 331.

7 Servicing

7.1 General

7.1.1 An appliance shall be provided with means of access for cleaning of parts such as heating surfaces in contact with combustion products, oil inlet pipes, and oil strainers, without major dismantling of the appliance or removal of parts required to be factory-assembled.

7.1.2 The removal of access panels, burners, blowers, and the like, permitting removal and replacement for servicing, and the detachment of the chimney connector are not considered major dismantling as defined by 7.1.1.

7.1.3 Accessibility shall be afforded for cleaning, inspection, repair, and replacement of all burners, controls, and safety devices when the appliance is installed as intended by the manufacturer. The disposition of parts in the assembly removed for servicing shall be such that their restoration, following removal, will not necessitate their realignment to secure their intended relationship with other parts of the assembly. Special facilities required for servicing to be performed by the operator shall accompany the appliance and be attached to or placed, per instructions, near the appliance at the time of installation.

7.1.4 The requirements of Section 36 are not applicable to mechanical service functions which are not normally performed with the equipment energized. Such functions include cleaning and replacement of strainers and oil filters.

7.2 Moving parts

7.2.1 Moving parts such as fan blades, which may cause injury shall be enclosed or guarded.

7.2.2 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)."

7.2.3 The distance from an opening in a required guard or enclosure to the moving part mentioned in 7.2.1 shall be in accordance with Table 7.1, but the minor dimension of the opening shall not in any case exceed 3 inches (76 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).

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Table 7.1
Dimensions of openings

Minor dimensions of openings[a]		Minimum distance from opening to moving part	
Inches	m	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	114.0
1	25.4	6-1/2	165.0
1-1/2	38.1	10-1/2	267.0
2	50.8	14-1/2	368.0
Over 2 inch	(over 50.8)	30	762.0

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

7.2.4 A moving part is not to be considered when judging compliance with 7.2.1 and 36.1 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

8 Base

8.1 The base, if provided, of an appliance shall be constructed of metal to provide equivalent strength and durability and comply with the construction requirements of Section 9, Casings.

9 Casings

9.1 An outer casing or jacket shall be made of steel or equivalent material, braced, reinforced or formed to avoid damage through handling in shipment, installation, and use. Sheet metal casings shall be made of steel having a minimum thickness of 0.020 inch (0.51 mm) if uncoated, or 0.023 inch (0.58 mm) if galvanized, or of nonferrous sheet metal having an average thickness of not less than 0.029 inch (0.74 mm).

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

9.3 A removable panel through which air is drawn for combustion shall be so constructed as to prevent it from being attached in a manner that may affect the intended performance of the appliance.

9.4 A removable panel shall be so constructed that it will not be interchangeable with other panels on the same appliance if interchange may affect the intended operation of the appliance.

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

9.6 The appliance shall be constructed so that a negative pressure created by an air-circulating fan cannot affect the combustion air supply or draw products of combustion into the cooking zone.

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9.7 A connection between the heat exchanger and the casing shall be constructed to prevent leakage of combustion products into the cooking zone.

10 Radiation Shields

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

11 Combustion Chambers

11.1 A combustion chamber and flueway shall be constructed of cast iron, sheet steel, or equivalent material. Sheet steel, if used, shall be such as to provide the strength, rigidity, durability, resistance to corrosion, and other physical properties equivalent to sheet steel having a minimum thickness of 0.042 inches (1.07 mm).

11.2 Combustion chamber (firebox) lining material, if used, shall be secured in place, and accessible for replacement with equivalent material.

11.3 Refractory liners that serve to line the combustion chamber or used as insulating material shall comply with the applicable requirements of the Outline of Investigation for Refractory Combustion Chamber Liners, UL 2576.

12 Heating Surface Joints

12.1 Joints in heating surfaces shall be welded, locked-seamed, machined and bolted or riveted. The tightness of a joint shall be equivalent to that afforded by lock-seaming and shall not depend primarily on cement for tightness. A slip or lap joint shall not depend solely upon friction of the joint itself for strength. Examples of some acceptable lock-seams are illustrated by Figure 12.1.

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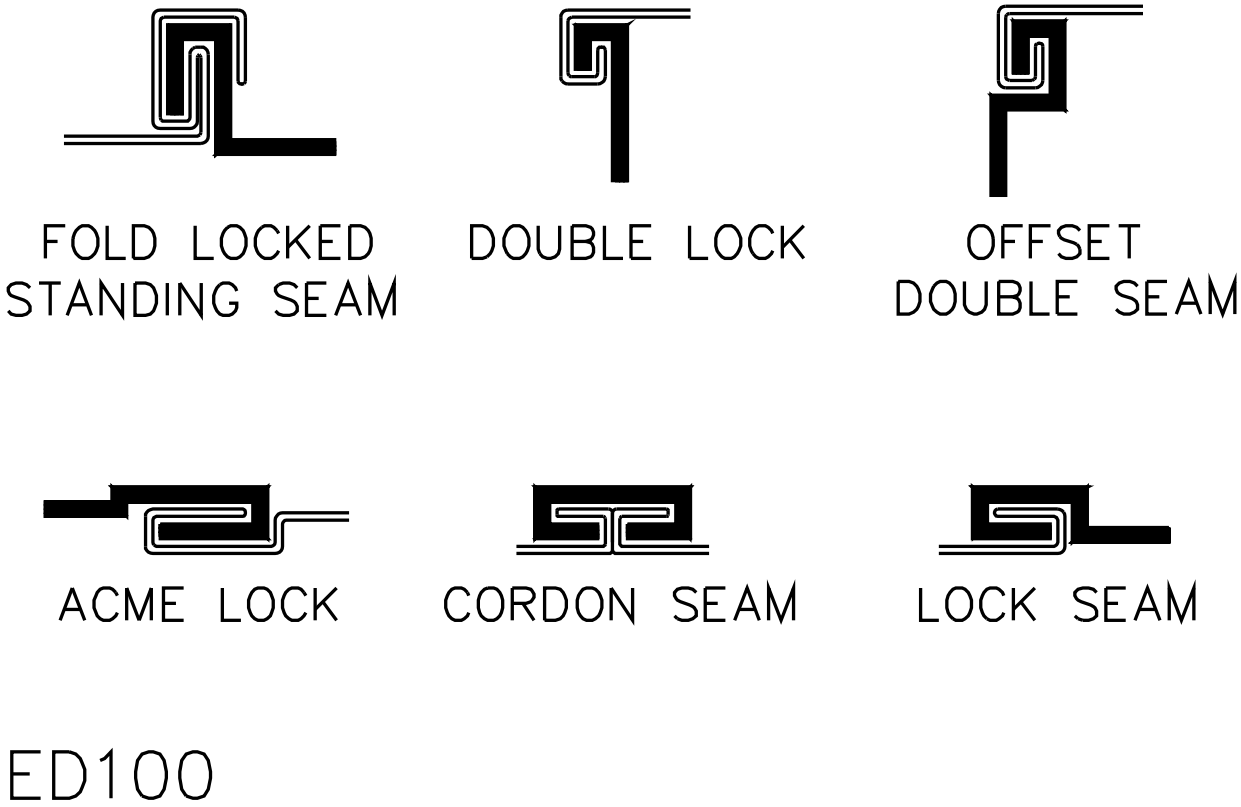
Figure 12.1
Types of acceptable lock-seams



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13 Baffles

13.1 A baffle in a flue-gas passage or otherwise exposed to combustion products 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 inches (1.07 mm) unless its deterioration will not cause excessive temperatures when the appliance is tested in accordance with these requirements.

13.2 A flue baffle shall be accessible for cleaning. A flue baffle that is removable for cleaning shall be such as to facilitate its removal and permit replacement only in its intended position.

14 Flue Collars

14.1 A flue collar shall be constructed and arranged to permit the attachment of the chimney connector.

14.2 A flue collar flue collector parts or extensions exterior to the cooking appliance shall have the rigidity, heat, and corrosion resistance at least equivalent to that of sheet steel having a thickness of not less than 0.016 inches (0.41 mm).

14.3 A flue collar or flue collector parts within the cooking appliance shall have the rigidity, heat and corrosion resistance at least equivalent to that of sheet steel having a thickness of not less than 0.042 inches (1.07 mm).

15 Dampers and Draft Regulators

15.1 A manually operated damper shall not be placed in the chimney connector/flue outlet of the appliance.

15.2 An adjustable automatic 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.

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

15.4 An appliance when 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.

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16 Air Intake Terminals

16.1 The requirements in this section are applicable to appliances equipped to provide all combustion and dilution air through an Air-Intake Terminal by an installation method.

16.2 An appliance shall be provided with a means for connection of an air-intake terminal to provide combustion air. The intake shall be provided with means for secure attachment to the appliance or building structure. An intake shall communicate with the outside atmosphere. The appliance shall be marked in compliance with 62.29. An air intake terminal equipped with a draft regulator shall provide adequate air for combustion when the air intake terminal opening is blocked.

16.3 An air-intake assembly through the roof shall be such that, when the assembly is installed as intended, the air entrance will be at least 6 inches (152.4 mm) above the top surface of the roof and the exit will be at least 6 inches below the bottom surface of the roof.

16.4 An air-intake assembly for installation through an outside wall shall extend at least 2 inches (50.8 mm) and not more than 4-3/4 inches (121 mm) beyond the inside face of the wall and shall not project beyond the outside wall more than 3 inches (76.2 mm).

16.5 The air entrance of an air-intake assembly shall be guarded, shielded, or located to exclude rain, snow, debris, and birds. A screen, if used, shall have a mesh of not less than 1/4 inch (6.4 mm) on centers.

16.6 Openings in perforated or expanded metal panels provided over openings for combustion air shall be a minimum 1/4 inch (6.4 mm) diameter. If the openings are other than circular in shape, they shall be of such size that will permit entrance of a No. 3 DMS (5.4102 mm) drill.

16.7 The design and path of an air-intake shall provide the intended amount of combustion air to the appliance and of dilution air to any draft regulator.

16.8 An outer casing or other structural part of an air-intake assembly or connector exposed to the weather shall be made of material having durability and resistance to corrosion, fire, and heat equivalent to that of galvanized steel, 0.018 inch (0.46 mm) thick, and have a coating of zinc conforming with the coating Designation G90 in the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of zinc coating may, in case of question, be established in accordance with the Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ANSI/ASTM A90. Such parts that are always inside the structure shall comply with 11.1.

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17 Direct Vent (Vent-Air Intake Assemblies)

17.1 The requirements in this section are applicable to direct vented appliance systems that provide for separation (isolation) of the combustion system from the indoor atmosphere by an installation method. Direct vented appliances shall be tested in accordance with Section 57, Direct Vent Appliance Tests.

Exception No. 1: The Direct Vent System Leakage Test, Load Test, and Impact Test are not required if the vent terminus provided with the appliance complies with the vent termination or cap requirements of the Standard for Venting Systems for Gas Burning Appliances, Category II, III, and IV, UL 1738.

Exception No. 2: The Direct Vent System Leakage Test, Load Test, and Impact Test are not required if the vent terminus provided with the appliance complies with the vent termination or cap requirements of the Standard for Gas Vents, UL 441.

17.2 An appliance shall be provided with a vent-air intake, as described in Section 16, Air Intake Terminals. The intake shall be provided with means for secure attachment to the appliance or building structure. The air intake and the vent terminal shall be located in the same plane and pressure zone in the outside wall of the building structure. The appliance shall be marked in compliance with 62.30.

17.3 Parts of flueway and airway shall be joined in a manner to prevent disengagement and shall be tight when tested in accordance with this standard. Joints of the flue gas conveying conduit should be designed to retain condensate and horizontal portions shall be installed at a minimum 1/4-inch (6.4 mm) rise to foot of run to route condensate back towards the appliance.

17.4 The assembly shall be provided with a cap to prevent the entrance of debris or rain into the flue-gas conveying pipe and into any air passages terminating outside the structure. The vent-air termination cap shall comply with the Combustion Test per Section 38, Combustion Test, and the Wind and Rain Tests per Section 58, Direct Vent Appliance Tests.

17.5 A cap shall be designed so that flue-gas or air passages will not be obstructed by soot accumulation, by leaves or debris falling or blown onto it, or by birds.

17.6 A vent-air-intake assembly intended for installation through the roof or outside wall shall be designed for varying thicknesses of roof and wall construction in accordance with 16.3 or 16.4.

17.7 An outer casing or other structural part of a vent-air intake assembly or connector exposed to the weather (exclusive of flue-gas conveying conduit) shall be constructed in accordance with 16.8.

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CONSTRUCTION – ELECTRICAL

18 Cord Connected Appliances

18.1 Power supply cords

18.1.1 An appliance intended for cord and plug connection to the supply circuit shall be provided with damp location, hard or extra hard usage flexible cord, such as Type S, SO, ST, STO, SJ, SJT, SJTO, HS, or HSO cord as described in the National Electrical Code, ANSI/NFPA 70. The length of the cord external to the appliance, measured to the face of the attachment plug, shall be no less than 2 feet (0.61 m) nor more than 6 feet (1.83 m).

18.1.2 The attachment plug provided with the cord shall be of the grounding type and shall be rated in accordance with Table 18.1. The attachment plug shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

Table 18.1
Attachment plug rating and supply cord size

Maximum load (amperes)		Supply cord (AWG)	Attachment plug rating (amperes)
More than	No more than		
0	10	18	15 or 20
10	12	16	15 or 20
12	13	16	20
13	16	14	20
16	18	12	30
18	24	10	30
24	25	10	40
25	30	8	40
30	32	6	40
32	40	6	50

18.1.3 The conductors of the cord shall be sized and rated in accordance with Table 18.1.

18.2 Bushings

18.2.1 At a point where a power supply cord passes through an opening in a wall, barrier, casing, or enclosure of the appliance:

a) There shall be a bushing or equivalent that is secured in place; or

b) The opening shall have a smooth, rounded surface against which the cord bears.

18.2.2 A soft bushing of rubber, neoprene, or polyvinyl chloride shall not be used at any point in the appliance unless the bushing is not relied upon to protect the cord insulation and the edges of the hole in which the bushing is mounted are smooth and free from burrs, fins, or any sharp edge.

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18.3 Strain and push back relief

18.3.1 Strain relief, other than a knot in a power supply cord, shall be provided such that mechanical stress on a power supply cord is not transmitted to terminals, splices, or internal wiring, as determined by the Strain Relief Test described in Section 48.1.

18.3.2 Means shall be provided to prevent the power supply cord from being pushed into the enclosure of the appliance through the cord entry hole when such displacement:

a) Subjects the cord to mechanical damage;

b) Exposes the cord to a temperature higher than that for which it is rated; or

c) Reduces spacings to values below the minimum values specified in Table 32.1.

To determine compliance, the supply cord shall be tested in accordance with the Push Back Relief Test, 48.2.

19 Controls

19.1 Application

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

19.1.2 It is the intent of the requirement in 19.1.1 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 19.1.1 may be acceptable if they accomplish the intent of this requirement.

19.1.3 The requirement of 19.1.1 does not apply to a circuit within a safety control or to the extension of such circuit to a separate element of the control, such as a flame-sensing device.

19.1.4 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.

19.1.5 All safety controls shall be accessible.

19.1.6 A safety control shall be supported so that it and its sensing element will remain in their intended positions. It shall be possible to determine by observation or test whether or not each control is in its intended location.

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

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

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19.1.9 An appliance equipped with an automatic ignition system shall be equipped with a primary safety control. A primary safety control shall be constructed and tested in accordance with the Standard for Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Burner Ignition Systems and Components, UL 372.

19.1.10 Components including contactors and sequence controllers that are operated by a safety control (Limit Control, Thermostat, Liquid Level Control) shall be rated for 100,000 cycles of operation and shall be arranged to result in the direct opening of that circuit, whether the switching mechanism is integral with the sensing element or remote from the element.

19.1.11 An ancillary control device located within a safety circuit and deemed a protective control by the third party safety certifier shall comply with the Standard for Limit Controls, UL 353 or the protective control requirements of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

19.2 Limit control – oil fired fryers

19.2.1 A deep fat fryer shall be provided with a limit control to provide safety shutdown and prevent the cooking oil from exceeding a temperature of 475°F (246°C).

19.2.2 An automatically lighted deep fat fryer shall be provided with an automatic-reset type limit control.

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

19.2.4 The purpose of the requirement in 19.2.3 is to avoid interposing in the limit-control circuit other controls, the failure of which may result in a condition that the limit control is intended to prevent. However, a limit control may interrupt the pilot circuit of a magnetic-type motor controller which, in turn, directly opens the safety circuit when it is necessary to interrupt a single-phase circuit carrying a load greater than the capacity of available limit controls, or to interrupt a multiphase circuit.

19.2.5 An electro-mechanical control shall comply with the Standard for Limit Controls, UL 353, or the requirements for protective electrical controls in the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

19.2.6 An electro-mechanical temperature-regulating control shall be investigated and found acceptable for continuous operation under rated electrical load for 100,000 cycles of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±6°C).

19.2.7 An electronic temperature-limiting control with switched outputs that only relies on hardware circuitry to limit the temperature within the limits specified in 19.2.1 shall comply with the requirements of:

a) The Standard for Limit Controls, UL 353, and;

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b) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 with no single points of failure permitted, or the Type 2 Protective Control requirements per the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

An electro-mechanical temperature-regulating control shall be investigated and found acceptable for continuous operation under rated electrical load for 100,000 cycles of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±6°C).

19.2.8 An electronic temperature-limiting control that relies on software to limit the temperature within the limits specified in 19.2.1 shall comply with the requirements for software Class 2 in accordance with the Standard for Software in Programmable Components, UL 1998 or software Class C in accordance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

19.3 Thermostats

19.3.1 A thermostat that controls continuous intended operation of an appliance at all settings shall comply with the requirements of the Standard for Limit Controls, UL 353 or the requirements for protective electrical controls in the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

Exception: Thermostats may comply with the Standard for Temperature Indicating and Regulating Equipment, UL 873, with the inclusion of the following tests:

a) The endurance test shall be conducted for 100,000 cycles; and

b) The calibration shall be verified following the endurance test to be within the tolerances specified.

Compliance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

19.3.2 Thermostats shall be accurately calibrated to conform to the markings on the dial. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±6°C).

19.3.3 Thermal elements and capillary tubes shall not be subject to mechanical damage in normal use. This may be accomplished either by their location or by separate protection.

19.3.4 An electronic control shall comply with the applicable requirements of 19.2.7 – 19.2.8.

19.3.5 Conveyorized, ferris wheel, carousel, and similar type appliances need not comply with this provision.

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19.4 Liquid level controls

19.4.1 When a liquid level control is required for intended operation, the control shall comply with the Standard for Limit Controls, UL 353 or the requirements for protective controls in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

20 Field Wiring

20.1 General

20.1.1 Provision shall be made for connection of a power supply wiring system conforming to the National Electrical Code, ANSI/NFPA 70.

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

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

20.1.4 The size of a junction box in which field-installed conductors are to be connected by splicing shall be not less than that indicated in Table 20.1. A conductor passing through the box is counted as one conductor, and each conductor terminating in the box is also counted as one conductor. A field-furnished conductor for high-voltage circuits is considered to be not smaller than 14 AWG (2.1 mm^2). Electrical (junction) boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A.

Table 20.1
Size of junction boxes

Size of conductors,		Free space within box for each conductor,	
AWG	(mm^2)	cubic inches	(cm^3)
16 or smaller	(1.3 or less)	1.5	(24.6)
14	(2.1)	2.0	(32.8)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.4)	3.0	(49.2)

20.1.5 A knockout for connection of a field wiring system to a terminal box or compartment shall accommodate conduit of the trade size determined by applying Table 20.2.

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Table 20.2
Trade size of conduit in inches (mm OD)

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

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

20.1.6 A junction box or enclosure in which field-installation conductors are to be connected shall be located so that the temperature of conductors within the box or surfaces of the box likely to be in contact with the conductors will not exceed the requirements for the material used, when the appliance is tested in accordance with these requirements.

20.2 Leads and terminals

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

20.2.2 A lead may be less than 6 inches (152 mm) long if it is evident that the use of a longer lead may result in damage to the lead insulation.

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

20.2.4 A terminal or lead for the connection of a grounded conductor shall not be electrically connected to a single-pole manual switching device that has an off position or to a single-pole overcurrent (not inherent overheating) protective device.

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

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20.2.6 Field-wiring terminals shall be secured to their supporting surfaces by methods other than friction between surfaces so that they will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than those required. This may be accomplished by two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by some other equivalent method.

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

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

20.2.9 Terminal parts by which field-wiring connections are made shall consist of soldering lugs or pressure terminal connectors secured in place in accordance with the requirements in 20.2.6, except that for 10 AWG (5.3 mm^2) and smaller wires, the parts to which wiring connections are made may consist of clamps or wire binding screws with cupped washers, terminal plates having upturned lugs, or the equivalent, to hold the wire in position.

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

Exception No. 1: A No. 8 (4.2 mm major diameter) screw may be used for the connection of a conductor not larger than 14 AWG (2.1 mm^2).

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

20.2.11 A terminal plate for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) in thickness for a 14 AWG (2.1 mm^2) or smaller wire, and not less than 0.050 inch (1.27 mm) in thickness for a wire larger than 14 AWG; and in either case there shall be not less than two full threads in the metal.

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

20.2.13 A wire-binding screw shall thread into metal.

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21 Internal Wiring

21.1 General

21.1.1 The wiring of high-voltage and safety-control circuits shall conform to the requirements in this section.

21.1.2 Wiring shall be done with insulated conductors having current-carrying capacity, voltage, and temperature ratings consistent with their use. A conductor, other than an integral part of a component shall be not smaller than 18 AWG (0.82 mm^2).

21.1.3 Except as indicated in 20.1.6, the wiring for all appliance circuits shall be furnished by the manufacturer as part of the appliance. If the appliance is not assembled and wired at the factory, such wiring shall be furnished as harness with each appliance and be arranged to facilitate attachment when the appliance is assembled; in which case a pictorial diagram showing the exact arrangement of the wiring shall be included with each appliance.

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

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

21.1.6 Internal wiring shall comply with the Standard for Thermoplastic-Insulated Wires and Cables, UL 83; the Standard for Thermoset-Insulated Wires and Cables, UL 44; or the Standard for Appliance Wiring Material, UL 758.

21.1.7 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B or the Standard for Splicing Wire Connectors, UL 486C.

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

21.2 Methods

21.2.1 Electrical wiring to a part which must be moved for maintenance and servicing shall be arranged so that the part may be moved without breaking soldered connections or disconnecting conduit. Conductors to be disconnected from terminals of such a part shall terminate in eyelets or connectors. If the wiring to a part which functions also as an access plate or cover, that is, a transformer closing the access to the nozzle assembly is not readily detachable, the assembly shall include provision for support of that part by means other than the wiring when the part is moved for servicing. Any allowable movement of such part shall not unduly twist, bend, or pull the wiring.

21.2.2 Conductors shall be enclosed within conduit, electrical metallic tubing, metal raceway, electrical enclosure, or metal-clad cable, except as permitted by 21.2.14 and 21.2.15.

21.2.3 Wire employed for the internal wiring of an appliance shall be rated and acceptable for the application. Examples of typically wiring materials are shown in Table 21.1.

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Table 21.1
Typical wiring materials

Group	Type of wire, cord, cable or appliance wiring material with insulation thicknesses shown at the right corresponding to wire sizes indicated	Wire size		Insulation thickness	
		AWG	(mm^2)	Inch	(mm)
A	FFH-2, TF, TFF, TFFN, SF-2, SFF-2, RH, RHH, RHW, THW, XHHW, MTW, THW-MTW, THWN, TW, PF, PFF, PCF, PGFF, RFH-2, RFHH-2, RFHH-3 or thermoplastic appliance wiring material	10 and smaller	(5.3)	2/64	(0.8)
		8	(8.4)	3/64	(1.2)
		6	(13.3)	4/64	(1.6)
		4	(21.2)	4/64	(1.6)
		3	(26.7)	4/64	(1.6)
		2	(33.6)	4/64	(1.6)
		1	(42.4)	5/64	(2.0)
		1/0	(53.5)	5/64	(2.0)
		2/0	(67.4)	5/64	(2.0)
		3/0	(85.0)	5/64	(2.0)
		4/0	(107.2)	5/64	(2.0)
B	SO, ST, SJO, SJT, S, SE, SJ, SJTO, SJTOO, SOO, STO, STOO, or appliance wiring materials with thermoplastic or neoprene insulation	18	(0.82)	4/64	(1.6)
		16	(1.3)	4/64	(1.6)
		14	(2.1)	5/64	(2.0)
		12	(3.3)	5/64	(2.0)
		10	(5.3)	5/64	(2.0)
		8	(8.4)	6/64	(2.4)
		6	(13.3)	8/64	(3.2)
Thermoplastic wiring materials, as referenced in Group A, with insulation thickness of 2/64 inch (0.8 mm) for 16 or 18 AWG (1.3 or 0.82 mm^2) and 3/64 inch (1.2 mm) for 14, 12, 10, or 8 AWG (2.1, 3.3, 5.3, or 8.4 mm^2), are considered equivalent to the wiring material referenced in Group B, when the conductors are covered with 1/32 inch (0.8 mm) wall thickness thermoplastic insulating tubing of a type recognized for the purpose from the standpoint of dielectric properties, heat resistance, moisture resistance, and flammability.					

21.2.4 Flexible metal conduit shall be not smaller than nominal 3/8-inch electrical trade size specified in the Standard for Flexible Metal Conduit, UL 1. This does not apply to parts of components, such as conduit protecting flame sensor leads.

21.2.5 Flexible metal conduit shall be mechanically secured at intervals not exceeding 4-1/2 feet (1.4 m) and within 12 inches (300 mm) on each side of every junction box except for lengths not over 36 inches (0.91 m) where flexibility is necessary.

21.2.6 All splices and connections shall be mechanically secure and bonded electrically. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in the risk of fire or electric shock.

21.2.7 A splice shall be provided with insulation equivalent to that required for the wires involved if permanence of spacing between the splice and other metal parts is not provided.

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