UL 391

STANDARD FOR SAFETY

Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces

UL Standard for Safety for Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces, UL 391

Fifth Edition, Dated September 10, 2010

Summary of Topics

This revision of ANSI/UL 391 dated August 28, 2019 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 UL'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 June 28, 2019.

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Standard for Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces

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The most recent designation of ANSI/UL 391 as a Reaffirmed American National Standard (ANS) occurred on August 19, 2019. 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 UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements apply to manually fueled, solid-fuel-fired central furnaces. Included are supplementary central furnaces intended for interconnection with forced-air central furnaces utilizing other fuels, and combination oil-fired and solid-fuel-fired, forced-air central furnaces.

1.2 The furnaces are intended to burn solid fuels, such as wood, coal, or any other biomass fuel, as specified by the manufacturer.

1.3 The furnaces are intended for connection to chimneys for residential and building heating appliances in compliance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211, and intended for installation in compliance with the Standard for Installation of Warm Air Heating and Air Conditioning Systems, NFPA 90B; and the National Electrical Code, ANSI/NFPA 70; and applicable mechanical codes such as the BOCA National Mechanical Code, the Standard Mechanical Code, and the Uniform Mechanical Code.

1.4 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

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. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

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 recognized rating established for the intended conditions of use.

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

3 Units of Measurement

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

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 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 air, secondary air, or both. It may be either manually or automatically operated.

5.3 APPLIANCE FLUE – The passages within the product that conduct the products of combustion (flue gases) through the product.

5.4 BURNER, OIL – 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.

5.5 CHIMNEY CONNECTOR – The pipe that connects a fuel-burning product to a chimney.

5.6 COMBUSTIBLE MATERIAL, COMBUSTIBLE PRODUCTS, NONCOMBUSTIBLE – These terms, as used in this standard, are defined in the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, NFPA 211.

5.7 CONTROL, LIMIT – An automatic control responsive to changes in pressure or temperature and intended to limit the operation of the controlled equipment.

5.8 CONTROL, PRIMARY SAFETY – The automatic control relied upon to reduce the risk of discharge of oil at the burner in case of loss of ignition or loss of flame.

5.9 CONTROL, SAFETY – Any automatic control, such as a relay or switch, used in conjunction with other auxiliary equipment to form a safety control system that is relied upon to reduce the risk of fire, electric shock, or injury to persons.

5.10 CONTROL, SAFETY COMBUSTION – A primary control directly responsive to flame properties. Senses the presence of flame and causes fuel to be shut off in event of loss of flame.

5.11 CONTROL, THERMOSTATIC DAMPER – An automatic control responsive to changes in temperature. Usually acts through direct mechanical linkage to reduce or increase the supply of air needed for combustion, thereby regulating the combustion rate and limiting the operation of the product when the product is burning solid fuel.

5.12 CONVENIENCE RECEPTACLE – A contact device provided with permanently connected electrical conductors intended for quick and easy connection to a plug attached to a flexible electric cord.

5.13 DAMPER – A valve or plate that regulates draft or flow of flue gases or inlet combustion air. May be either manually or automatically operated.

5.14 DRAFT REGULATOR – A device that functions to maintain a desired draft in the product by automatically reducing the chimney draft to the desired value.

5.15 ELECTRICAL CIRCUITS:

a) High-Voltage Circuit – A circuit involving a potential of not more than 600 volts and having circuit values 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 NEC Class 2 transformer, or by a battery, or by a battery and fixed impedance, or by a transformer and fixed impedance each of which, as a unit, is either in compliance with requirements for a Class 2 transformer or is otherwise limited to a maximum output of 100 volt-amperes. A circuit derived by connecting resistance in series with a high-voltage circuit as a means of limiting the voltage and current is not considered a low-voltage circuit.

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

5.16 FLOOR PROTECTOR (STOVE MAT) – The noncombustible material applied to the floor area underneath, in front of, and at the sides of the fuel charging area and underneath the chimney connector area of the product.

5.17 FUEL OIL – Any hydrocarbon oil defined by the Standard for Specification for Fuel Oils, ANSI/ ASTM D396.

5.18 FURNACE, CENTRAL – A self-contained indirect-fired product supplying heated air through ducts to the space to be heated. Air is circulated either by means of a power-driven fan (a forced-air furnace) or by means of natural convection (a gravity furnace).

5.19 FURNACE, COMBINATION OIL-FIRED AND SOLID-FUEL-FIRED CENTRAL – A central furnace burning fuel oil and solid fuel either separately or simultaneously. The furnace makes use of either separate or common combustion chambers and flues for burning the two fuels.

5.20 FURNACE, SUPPLEMENTARY CENTRAL – A solid-fuel-burning product intended to be interconnected with a gas- or oil-fired forced-air central furnace by means of a common warm-air supply plenum in accordance with the manufacturer's instructions.

5.21 GRATE – A metal frame provided by the manufacturer for supporting the fuel within a furnace.

5.22 HEARTH – The floor area within the fire chamber of a furnace.

5.23 INDIRECT-FIRED VENTED PRODUCT – A product in which the products of combustion and the medium being heated (circulating air, for example) are segregated by the walls of the fire chamber and flues; it is provided with a flue collar to accommodate a chimney connector for conveying the products of combustion to the outdoors.

5.24 RADIATION SHIELD – A separate panel or separate panels interposed between heating surfaces and adjacent objects for the purpose of reducing heat transmission by radiation.

5.25 RADIATOR – Auxiliary heat transfer surfaces within the casing, connected between the combustion chamber and the flue collar.

5.26 SERVICING – The periodic tasks usually performed to operate and maintain a product, such as air, fuel, and pressure adjustments, cleaning of flues and chimney, lubrication, and resetting of controls. Repair and replacement of parts other than those expected to be renewed periodically, such as replacement of air filters, is not considered to be servicing. Some examples of servicing are:

a) Cleaning or replacing nozzles;

b) Setting ignition electrodes;

c) Cleaning or replacing strainer or filter elements;

d) Resetting safety control; and

e) Replacing igniter cable.

CONSTRUCTION

6 General

6.1 A furnace shall be factory built as a complete assembly and shall include all the components necessary for its intended installation and operation. A furnace may be shipped as two or more major subassemblies.

6.2 Major subassemblies of a furnace are considered to be:

a) The burner;

b) The heat exchanger, including its base, combustion chamber, casing, and safety controls;

c) The blower assembly, including its base, filters, and casing; and

d) The blower motor, if not included as part of the blower assembly.

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

6.3 A furnace shall be arranged in major subassemblies, if the furnace is not assembled by the manufacturer as a unit. Each subassembly shall be capable of assembly into the final assembly without the installer altering, cutting, drilling (except as indicated in 6.4), threading, welding, or performing similar tasks. If the intended installation and operation of the furnace so requires, two or more subassemblies shall either:

a) Be arranged and constructed so that they can be incorporated into the complete assembly only in the intended manner; or

b) Be assembled, tested, and shipped from the factory as one element.

6.4 Cutting or drilling complies with the requirements of 6.3 if it is needed for either:

a) The attachment of a return or supply plenum or an optional filter rack; or

b) The provision of a return-air opening in the furnace casing. If a return-air opening is to be cut in the casing panel by the installer, either the necessary instructions and template shall be furnished with the furnace, or the corners of the opening shall be embossed in knockout form.

6.5 A radiation shield or baffle relied upon to reduce the risk of temperatures in excess of those intended shall:

a) Be assembled as part of the furnace;

b) Be part of a subassembly that must be attached to the furnace for its intended operation; or

c) Be constructed so that the furnace cannot be assembled for operation without first attaching a required shield or baffle in its intended position.

6.6 Alteration or removal of a baffle, insulation, or radiation shield needed to reduce the risk of excessive temperatures shall not be required for any intended furnace installation.

6.7 The construction of a furnace shall permit the user to operate those parts requiring the user's attention or adjustment in anticipated usage.

6.8 An adjustable or movable part shall be provided with a locking device to secure it against unintended shifting.

6.9 A screw or bolt used to attach a part that may be detached for care or servicing of the product shall hold its position upon the application of the torque specified in Table 6.1 after removal and replacement of the part.

Table 6.1
Torque requirements for screws or bolts

American standard screw size		Torque		I.S.O. screw size	Torque	
No.	**mm**	**Lb-inch**	**N·m**	**mm**	**N·m**	**Lb-inch**
–	–	–	–	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**	**Lb-inch**	**N·m**	**mm**	**N·m**	**Lb-inch**
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

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

6.11 A furnace intended for installation in the cooled-air path, downstream from a cooling coil, shall comply with (a) – (d):

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

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

c) Condensation shall not drip on burner parts or other parts vulnerable to corrosion if corrosion of any of the parts may cause a risk of fire, electric shock, or injury to persons.

d) The heat exchanger and appliance flue shall not contain traps or pockets in which condensation may collect.

6.12 An oil burner shall be secured so that it will not twist, slide, or drop out of position.

6.13 A grate shall be used in a furnace intended to burn coal.

6.14 When a user's hand is withdrawn from a separable door handle (if provided) that is intended to be used either during solid-fuel loading and ash removal or with products requiring manual operation, the handle shall not remain in a position that allows temperatures on the handle to rise above those specified in Table 57.1.

6.15 Provision shall be made for storing a separable handle on the furnace. When the handle is stored in its intended position, its temperature shall not exceed the appropriate temperature specified in Table 57.1.

6.16 Fuel-loading and ash-removal doors shall not warp or misalign when the furnace is subjected to the tests specified in the Performance section of this standard if air leaking into the combustion chamber because of the warping or misalignment can result in a risk of overfiring or fire outside the furnace.

6.17 Fuel-loading and ash-removal doors shall close by gravity or shall be provided with a latch. Combination oil-fired and solid-fuel-fired furnace doors shall not open during delayed oil ignition unless it can be determined that particles of burning solid fuel cannot be expelled through the door opening by the force of the delayed oil ignition. See Delayed Oil Ignition Test, Section 60.

6.18 A combination oil-fired and solid-fuel-fired central furnace shall be provided with an interlock relied upon to reduce the risk of firing of the oil burner with either or both the solid-fuel loading door or the ash-removal door open, if this operation can result in the risk of fire, explosion, or injury to persons.

7 Accessibility for Servicing

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

7.2 With reference to the requirements of 7.1, the removal of access panels, burners, blowers, caps, plugs, and the like, permitting removal and replacement of parts for servicing, and the detachment of the chimney connector are not considered major dismantling.

7.3 All burners, controls, and safety devices shall be accessible for cleaning, inspection, repair, and replacement when the furnace is installed as intended by the manufacturer. Parts in the assembly removable for servicing shall be arranged so 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 furnace as supplied by the user.

8 Protection of Users and Service Personnel

8.1 An uninsulated, high-voltage live part or a moving part that creates a risk of injury to persons shall be located, guarded, or enclosed so as to reduce the risk of unintended contact by personnel performing service functions that may have to be performed while the equipment is energized.

8.2 Service functions that may have to be performed while the equipment is energized include:

a) Adjusting the setting of temperature controls that do or do not have marked dial settings;

b) Resetting a control trip mechanism;

c) Operating manual switches; and

d) Adjusting air-flow dampers.

A factory-set and -sealed control is not considered adjustable.

8.3 The requirements of 8.1 are not applicable to mechanical service functions not anticipated to be performed while the equipment is energized. Such functions include adjusting or replacing belts and cleaning and replacing strainers and oil filters.

8.4 Adjustable or resettable electrical control or manual switching devices may be located or oriented with respect to uninsulated high-voltage live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the intended direction of access if uninsulated, high-voltage live parts or moving parts involving a risk of injury to persons are:

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

b) Are not located within 6 inches (150 mm) of the mechanism, whether the parts are positioned on any side of the mechanism or whether they are behind it, unless they are guarded.

8.5 The location and mounting of an electrical control component relative to other components and grounded metal parts shall not subject service personnel to risk of electric shock from adjacent uninsulated live parts or the risk of injury from adjacent moving parts if components need to be reached while it is energized.

Exception: This requirement does not apply when service personnel make voltage measurements using jacks or terminals specifically intended for the purpose.

8.6 Accessibility to each compartment and protection of persons from the risk of electric shock and contact with moving parts that can cause injury may be obtained by mounting the control components in an assembly so that unimpeded access is provided to each compartment through an access cover or panel in the outer cabinet and through the cover of the control assembly enclosure described in (a) – (e). See Figure 8.1.

a) The components shall be located with respect to the access opening in the outer cabinet so that the farthest component in the control assembly is not more than 14 inches (355 mm) from the plane of the access opening.

b) Uninsulated live parts that lie outside the control assembly's projected clear space (except for live parts within a control panel) or unguarded moving parts that create a risk of injury to persons shall be located not closer than 6 inches (150 mm) to any side of the access area. The projected clear space is considered to be bounded on the sides by the projection of the smallest rectangular perimeter that can surround the outside edge of the components or control enclosure, when such an enclosure is provided. The access area is considered to be bounded on the sides by the projection of the perimeter of the access opening in the outer cabinet to the closest rectangular perimeter surrounding the outside edge of the component or control enclosure.

c) The volume generated by the projected clear space of the control assembly to the access opening in the outer cabinet (within the access area) shall be free of obstructions, including wiring.

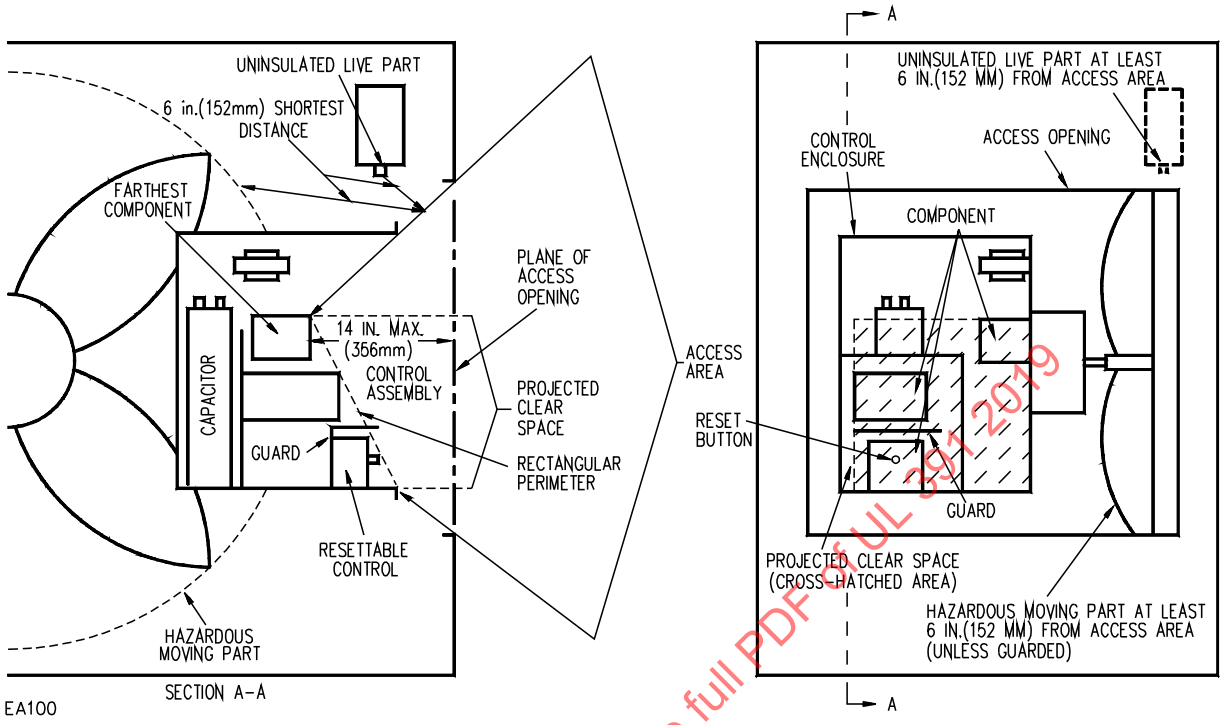
d) Access to the components in the control assembly shall not be impeded in the direction of access by other components or by wiring in this assembly.

e) Extractor-type fuseholders and snap switches mounted through the control assembly enclosure shall be located so that:

1) There is unimpeded access to these components through the access opening in the outer cabinet; and

2) The components are not immediately adjacent to uninsulated live parts outside the control assembly enclosure, unless these parts are guarded. See 40.4.

Figure 8.1
Accessibility and protection



8.7 A component in a low-voltage circuit shall comply with the requirements of 8.5 in its relation to uninsulated live parts in a high-voltage circuit and to moving parts that can cause a risk of injury to persons.

8.8 The following are not considered to be uninsulated live parts:

a) Coils of controllers, relays, and solenoids;

b) Transformer windings, if the coils and windings are provided with insulating overwraps;

c) Enclosed motor windings;

d) Insulated terminals and splices; and

e) Insulated wire.

8.9 A moving part, such as a fan blade, blower wheel, pulley, or belt that may cause injury to persons, shall be enclosed or guarded.

8.10 The distance from an opening in the guard or enclosure specified in 8.9 to the moving part shall be as specified in Table 8.1, but the minor dimension of the opening shall not exceed 3 inches (76 mm). For an opening having a minor dimension intermediate between two of the values indicated 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 to be determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22 N).

Table 8.1
Dimensions of openings in enclosure

Minor dimensions of opening[a]		Minimum distance from opening to moving part	
Inches	(mm)	Inches	(mm)
1/4	(6.4)	1/2	(12.7)
3/8	(9.5)	1-1/2	(38.1)
1/2	(12.7)	2-1/2	(63.5)
3/4	(19.1)	4-1/2	(114)
1	(25.4)	6-1/2	(165)
1-1/2	(38.1)	10-1/2	(267)
2	(50.8)	14-1/2	(368.0)
Over 2	(over 50.8)	30	(762.0)

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

8.11 A moving part is not to be considered when compliance with the requirements of 8.1 and 8.9 is determined, if the part is unlikely to be contacted through the opening because of intervening fixed components, including baffles.

8.12 An interlocking device that disconnects the drive motor from its source of power when a door or panel is opened or removed to provide access to moving parts complies with the requirement of 8.9.

8.13 A moving part, as specified in 8.9, driven by a motor that is started or restarted by an automatic cycling device such as a fan control or thermal protector, shall be guarded if it is exposed when air filters are changed or anticipated adjustments are made.

Exception: This requirement does not apply if the access door or panel requires the use of a tool for opening or removal or if an interlock device of the type specified in 8.12 is provided.

8.14 The scroll of a centrifugal blower is a suitable guard for the blower wheel.

9 Base

9.1 The base of a furnace shall be constructed of metal or of other nonflammable material providing strength and durability equivalent to that of metal.

10 Casings

10.1 An outer casing or jacket shall be made of steel or material of equivalent strength, reinforced or formed if necessary to reduce the risk of damage from 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 the steel is uncoated, or 0.023 inch (0.58 mm) if galvanized. Casings may also be of nonferrous sheet metal having an average thickness of not less than 0.029 inch (0.74 mm).

10.2 Access panels that may be removed for servicing or for other reasons shall permit repeated removal and replacement without damage and without impairment of any required insulating property.

10.3 A removable panel through which air is drawn for combustion shall be constructed so that it cannot be attached in a manner that may affect the intended performance of the furnace.

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

10.5 The casing of a furnace 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. However, an opening intended to be permanently connected to a circulating-air distribution duct meets the intent of the requirement.

10.6 The casing of a forced-air-type furnace shall have no uncovered opening communicating with the circulating air compartments unless:

a) Such an opening is intended to be permanently connected to a circulating air distribution duct; or

b) The opening is automatically closed by a shutter or cover when the circulating-air fan or blower is operated, and the automatic closing latches the shutter or cover in the closed position and requires manual opening.

10.7 The furnace shall be constructed so that the operation of an air-circulating fan will not affect the combustion air supply or draw products of combustion into the circulating air.

10.8 A connection between the heat exchanger and the casing enclosing circulating air shall be constructed so that combustion products will not leak into the circulating air.

10.9 An access opening to a return-air compartment shall be completely covered.

10.10 A furnace shall provide for the attachment of warm-air outlet ducts and cold-air return ducts.