34.4 General use attachment-plug receptacles on equipment intended to be used outdoors or in wet or damp locations shall be provided with a Class A ground-fault circuit interrupter (GFCI) with open neutral protection. The convenience receptacle shall be located so that it does not become wet during normal operation.

34.5 All nominal 120 Volt receptacles provided on equipment intended to be installed outdoors or in a wet location shall have a weathereproof cover enclosure that is marked for use in wet locations.

34.6 A receptacle that is intended to be employed for servicing the unit, shall be powered from the line side of the equipment main disconnect, except as noted in 34.8. A receptacle powered from the line side of the equipment disconnect shall be marked in accordance with 71.1(k).

34.7 A receptacle powered from the line side of the equipment disconnect shall have an enclosure and cover separate from servicable electrical components and live metal parts controlled by the equipment main disconnect.

34.8 When a receptacle is powered from a separate branch circuit, it shall be located in a separate enclosure and marked in accordance with 71.1(l).

35 Motors and Motor (Overload) Protection

35.1 A motor shall be protected by an integral thermal protector or by overload protective devices or by a combination of these.

35.2 An overload protective device specified in 35.1 is one that complies with the requirements of the National Electrical Code, ANSI/NFPA 70, as follows:

a) A separate overload device that is responsive to motor current shall be rated or selected to trip at not more than the following percent of the motor full-load current rating:

125 percent – For a motor with a marked service factor of not less than 1.15

125 percent – For a motor with a marked temperature rise of not more than 40°C (72°F)

115 percent – For any other motor

For a multispeed motor, each winding connection is to be considered separately and the motor shall be protected at all speeds.

b) If the value specified for motor-running overload protection does not correspond to the standard sizes or ratings of fuses or of magnetic or thermal-overload protective devices, a fuse or protective device of the next higher size or rating may be used, but the rating shall be not higher than the following percent of motor full-load current rating:

140 percent – For a motor with a marked service factor of not less than 1.15

140 percent – For a motor with a marked temperature rise of not more than 40°C (72°F)

130 percent – For any other motor

35.3 An integral thermal protective device shall comply with the Standard for Overheating Protection for Motors, UL 2111 or the Standard for Thermally Protected Motors, UL 1004-3.

UL 1004-3 will replace Part III of UL 2111 effective September 15, 2014

35.4 A separate overload device, except when included as part of a magnetic motor controller, shall be assembled as part of the equipment and shall be identifiable as such after assembly to the equipment. This protection shall not include means for manually interrupting the motor circuit if the interruption can increase the risk of fire, electric shock, or injury to persons.

35.5 Except as indicated in 35.6, 3-phase motors shall be provided with overcurrent protection as follows:

a) Three acceptably rated overcurrent devices shall be employed; or

b) Thermal protectors, combinations of thermal protectors and overcurrent devices, or equivalent methods of protection may be employed where the specific protective arrangement has been investigated and found to provide protection under primary single-phase failure conditions when supplied from transformers connected wye-delta or delta-wye. Assemblies so investigated shall be marked as specified in 72.6.

35.6 If the assembly is of such a construction that it is not intended to be installed in isolated, inaccessible, or unattended locations, then two acceptably rated overcurrent devices, or equivalent thermal protection, may be employed, provided that the furnace is marked as specified in 72.13.

35.7 ″Unattended″ as used in 35.6 is defined as lacking the presence of a person capable of exercising responsible control of the motor under consideration. This person need not be an electrician. Also, he need not be in sight of the motor at all times but must be available for opening the motor circuit in the event of motor overheating.

35.8 A direct-drive fan motor or other such motor that is not intended to be subjected to overloads and that is protected by a thermal or overcurrent protective device against overheating caused by locked-rotor current meets the intent of the requirement provided that the motor will not overheat when operated under the severest anticipated conditions of use.

35.9 Impedance protection may be used in a motor to reduce the risk of overheating caused by locked-rotor current if the motor will not overheat during the performance tests of this standard. However, impedance protection does not meet the intent of the requirement for protection in a situation where a motor is installed in a compartment handling air for circulation to the conditioned space.

35.10 A fuse shall not be used as a motor overload protective device unless the largest fuse that can be inserted in the fuseholder provides the required protection for the motor.

35.11 In no case shall interruption of the circuit to a motor by the overcurrent or overtemperature protective device result in operation of the equipment that creates risk of fire, electric shock, or injury to persons or discharge of fuel. If a burner depends upon the operating of an electric valve to stop the flow of fuel to the burner, the interruption of the circuit to the motor by the protective device shall also cause the interruption of the circuit to the valve.

35.12 An automatic-reset protective device shall not be used if the automatic reclosing of the circuit to the motor by the device can result in operation of the equipment that increases the risk of fire, electric shock, or injury to persons.

35.13 The enclosure of a motor shall have no openings that will permit a drop of liquid or a particle falling vertically onto the motor to enter the motor.

35.14 Compliance with the requirement of 35.13 may be provided by the motor frame or another enclosure, structure, shield, or a combination of two or more such items. Compliance is to be determined while the motor is integrated into the assembly.

35.15 A motor having openings in the enclosure or frame shall be installed or shielded so that particles cannot fall out of the motor onto flammable material located within or under the assembly.

35.16 The requirement of 35.15 necessitates the use of a barrier of nonflammable material under an open-type motor unless:

a) The structural parts of the motor or the burner, such as its bottom closure, provide the equivalent of such a barrier; or

b) The motor overload protective device provided with a single-phase motor is such that no burning insulation or molten material falls to the surface that supports the product when the motor is energized under each of the following fault conditions, as applicable to the particular type of motor:

1) Open main winding;

2) Open starting winding;

3) Starting switch short-circuited; and

4) Capacitor shorted, permanent split capacitor type; or

c) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) and that is relied upon to prevent the temperature of the motor windings from becoming more than:

1) 125°C (257°F) under the maximum load below which the motor will run without causing the protector to cycle; and

2) 150°C (302°F) with the rotor of the motor locked; or

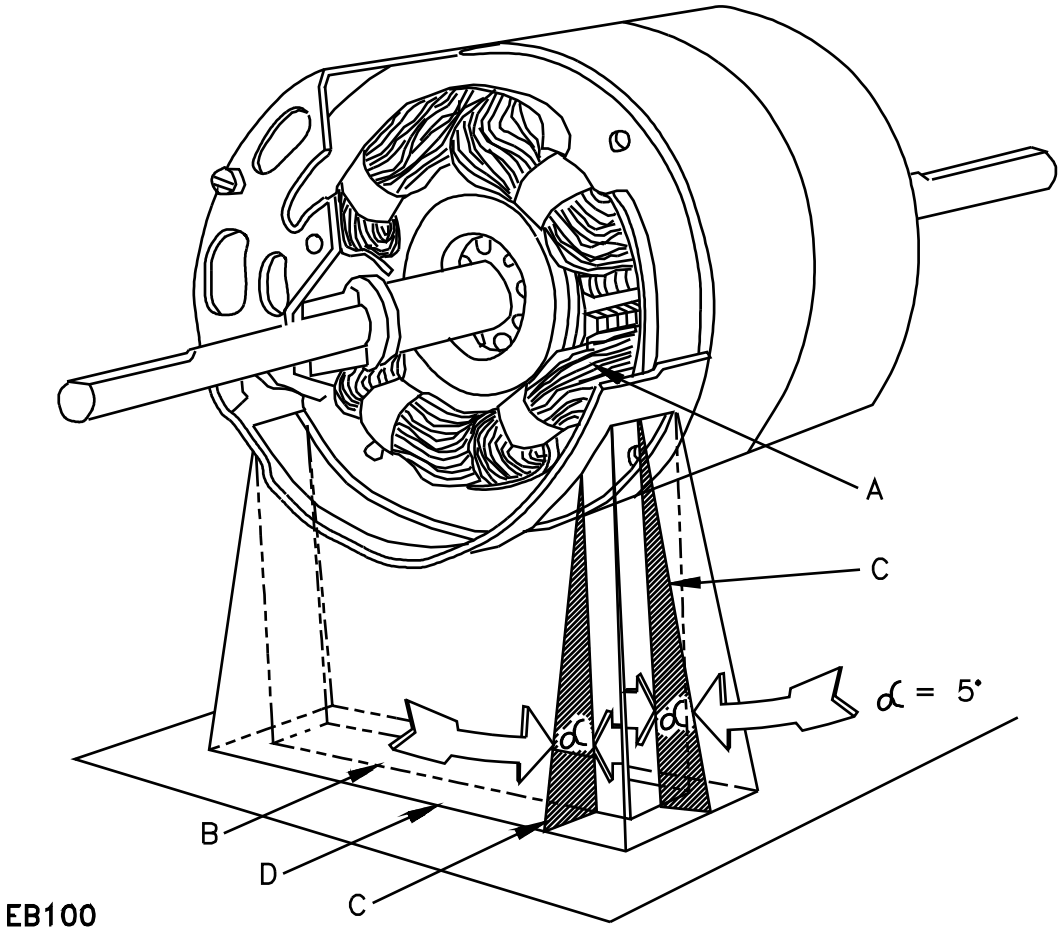
d) The motor complies with the requirements for impedance-protected motors, and the motor winding does not exceed a temperature greater than 150°C (302°F) during the first 72 hours of operation with the rotor of the motor locked.

35.17 The barrier specified in 35.16 shall be horizontal, shall be located as indicated in Figure 35.1, and shall have an area not less than that described in Figure 35.1. There may be openings for drainage and ventilation in the barrier provided that the openings do not permit molten metal, burning insulation, or the like, to fall on flammable materials.

35.18 An overcurrent protective device or a thermal protective device for motors shall comply with the requirements of the Short-Circuit Test, Section 68.

Figure 35.1
Location and extent of barrier

LOCATION AND EXTENT OF BARRIER



A – Motor winding to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding which is partially shielded by the motor enclosure or equivalent.

B – Projection of outline of motor winding on horizontal plane.

C – Inclined line which traces out minimum area of the barrier. When moving, the line is to be always:

1) Tangent to the motor winding;

2) Five degrees from the vertical; and

3) So oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is to be that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

36 Safety Controls and Circuits

36.1 General

36.1.1 A safety control circuit shall be 2-wire, one side grounded, and have a nominal rating of 120 volts. A safety control or protective device shall interrupt the ungrounded conductor.

36.1.2 The control circuit shall not allow short circuits to ground to impair the operation of a safety control or protective device. A safety-control-circuit arrangement other than that described in 36.1.1 shall be evaluated to determine if it accomplishes the intent of the requirement.

36.1.3 The requirement of 36.1.1 does not apply to a circuit within a safety control or to the extension of such a circuit to a separate element of the control, such as a flame-sensing device.

36.1.4 A control circuit shall be arranged so that it may be connected to a power-supply branch circuit that can be protected against overcurrent at not more than the value appropriate for the rating of any control included in the circuit in accordance with the National Electrical Code, ANSI/NFPA 70.

36.1.5 All safety controls shall be accessible.

36.1.6 A safety control shall be supported so that the control 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 position.

36.1.7 A furnace shall have no provision for rendering a safety control ineffective, nor shall the furnace be capable of being fired without the supervision of each of the required safety controls.

36.2 Fan, limit, and thermostatic damper controls

36.2.1 A furnace equipped with an oil burner shall be provided with an automatic-reset limit control that is relied upon to prevent temperatures from rising above the permitted maximum values. The need for a limit control on furnaces firing solid fuel to limit the temperatures for the outlet air and for parts of the furnace is to be determined by the Air Flow Restriction and Disruption Tests, Section 59.

36.2.2 If a furnace is equipped with a limit or thermostatic damper control relied upon to prevent excessive temperatures, the maximum setting permitted by the fixed stop on a limit or thermostatic damper control shall permit an outlet-air temperature of not more than that specified in 56.1.1.

36.2.3 A safety limit control or thermostatic damper control that functions to interrupt or reduce the delivery of fuel or air for combustion by opening an electrical circuit shall be arranged to directly open that circuit, whether the switching mechanism is integral with or remote from the sensing element. No other control that might malfunction to render the limit control ineffective shall be interposed between the limit control and the electrical circuit it governs.

Exception: A limit control may interrupt the pilot circuit of a magnetic-type motor controller that in turn directly opens the safety circuit when it is necessary to interrupt either:

1) A multiphase circuit; or

2) A single-phase circuit carrying a load greater than the capacity of available limit controls.

36.2.4 A thermostatic damper control relied upon to limit maximum temperatures shall comply with the Standard for Limit Controls, UL 353.

36.2.5 If a combustion-air damper or shutter or fan motor must be operated and controlled by means of a limit or thermostatic damper control to limit maximum temperatures, the entire operating mechanism, including the damper or shutter, crank arms, chains, connecting rods, and associated linkages, shall be located and guarded to reduce risk of tampering or physical damage. Electrical circuits shall be arranged to directly open the damper or fan-motor circuit.

36.2.6 A forced-air or a supplementary central furnace shall be provided with a fan control to start the fan or blower when air in the warm-air supply plenum reaches a temperature not higher than 93°C (200°F), even though a regulating thermostat may have been satisfied.

36.3 Supplementary central furnace controls

36.3.1 A supplementary furnace intended for installation in a parallel-air-flow arrangement with a central furnace shall be equipped with fan controls and dampers or other means to block reverse air flow in the central and supplementary furnaces or to block recirculation of any portion of the circulating air during separate or simultaneous operation of any fan or blower in the two-furnace system.

36.3.2 A supplementary furnace intended for installation in a series-air-flow arrangement with a central furnace shall be equipped with the following controls:

a) An operating control that cycles the gas or oil burner of the central furnace on and off so that the air-temperature rise through the two furnaces will not exceed 72°C (130°F) when the supplementary furnace is firing.

b) An automatic-reset limit control with the maximum set-point stop fixed for operation at a warm-air supply temperature greater than the set point of the operating control referenced in (a) above. Operation of the limit control shall shut off the gas or oil burner of the central furnace when the supply-air temperature is not higher than the temperature specified in 56.1.1.

36.4 Primary safety control

36.4.1 A combination oil-fired and solid-fuel-fired furnace that incorporates a common combustion chamber or flue for firing the two fuels shall be equipped with a primary safety control for the oil burner. To reduce the risk of hot coals or embers remaining in the combustion chamber from previous firing with solid fuel resulting in delayed ignition of the oil burner and to limit the amount of fuel that may be thus ignited, the safety control shall have a nominal trial-for-ignition period not exceeding:

a) 15 seconds for inputs of 20 gallons (76 L) per hour and less.

b) 4 seconds for inputs over 20 gallons per hour.

37 Switches and Controllers

37.1 Except as permitted in 37.2, a controller for regulating the loads involved shall be provided for all assemblies incorporating more than one motor intended for connection to the same power supply.

37.2 A controller is not required for an assembly having more than one motor if the marked, maximum fuse size does not exceed 20 amperes at 125 volts or less, or 15 amperes at 126 – 600 volts, and the full-load current of any motor does not exceed 6 amperes.

37.3 A single controller may control more than one motor if the controller is rated for the combined load controlled. The assembly shall be marked in accordance with 72.4 if the same controller contacts handle remote motors in addition to handling motors in the unit containing the controller.

37.4 A controller or switch shall be rated for the load that it controls.

37.5 The load controlled shall include any load external to the assembly for which connections in the controller or switch circuit are provided.

37.6 A controller that may be called upon to break a motor load under locked-rotor conditions shall have a current-interrupting capacity of not less than the locked-rotor load of the motor controlled.

37.7 If the controller is cycled by the operation of an automatic-reset overload device, it shall function as intended when subjected to an endurance test under locked-rotor conditions. The endurance test is to be of a duration equivalent to that required for the overload device and is to be manually cycled at a rate equivalent to that provided by automatic cycling of the overload device.

37.8 The locked-rotor load of a motor is to be based on:

a) Six times the full-load current rating of the motor, in the case of an alternating current motor; and

b) Ten times the full-load current rating, in the case of a direct current motor.

37.9 Two or more motors, each having individual running overcurrent protection, may be connected to the same power supply if:

a) The marked maximum overcurrent-protective-device rating of the furnace does not exceed the maximum size for protecting the motor of the smallest rating; and

b) A protective device of the marked size will not open under the most severe conditions of intended use that can be encountered.

37.10 Motor controllers shall be arranged so that they will simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

SPACINGS

38 High-Voltage Circuits

38.1 Except as noted in 38.2 – 38.4, spacings between uninsulated live parts of opposite polarity or between an uninsulated live part and a dead metal part shall be not less than the values indicated in Table 38.1.

Table 38.1
Minimum spacings

Ratings		Minimum spacings[a,b]					
Volt-amperes	Volts	Through air		Over surface		To enclosure[c]	
		Inch	(mm)	Inch	(mm)	Inch	(mm)
0 – 2000	0 – 300[d]	1/8[e]	(3.2)	1/4[f]	(6.4)	1/4	(6.4)
More than 2000	0 – 150	1/8[e]	(3.2)	1/4[f]	(6.4)	1/2	(12.7)
	151 – 300	1/4	(6.4)	3/8[g]	(9.5)	1/2	(12.7)
	301 – 600	3/8	(9.5)	1/2[c]	(12.7)	1/2	(12.7)

[a] An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material employed where spacings would otherwise be insufficient, shall not be less than 0.028 inch (0.7 mm) in thickness, except that a liner or barrier not less than 0.013 inch (0.33 mm) in thickness may be used in conjunction with an air spacing of not less than one-half of the through air spacing required. The liner shall be located so that it will not be damaged by arcing. Material having a less thickness may be used if it has equivalent insulating, mechanical, and flammability properties.

[b] The spacings at wiring terminals of a motor shall be 1/4 inch (6.4 mm) for a motor rated 250 volts or less and 3/8 inch (9.5 mm) for a motor rated more than 250 volts.

[c] Includes fittings for conduit or metal-clad cable.

[d] If over 300 volts, spacings in last line of table apply.

[e] The spacings between wiring terminals of opposite polarity, or between a wiring terminal and grounded metal, shall not be less than 1/4 inch (6.4 mm), except that if short-circuiting or grounding of such terminals will not result from projecting strands of wire, the spacing need not be greater than that given in the above table. Wiring terminals are those connected in the field and not factory wired. Measurements are to be made with solid wire of adequate ampacity for the load connected to each terminal.

[f] The over surface spacing for a glass-insulated motor terminal may be 1/8 inch (3.2 mm).

[g] The over surface spacing for a glass-insulated motor terminal may be 1/4 inch (6.4 mm).

38.2 A through-air and over-surface spacing at an individual component part is to be judged on the basis of the total volt-amperes consumption of the loads that the component controls. However, the spacing from the component to the enclosure is to be judged on the basis of the total load on all components in the enclosure. For example, a through-air or over-surface spacing at a component that controls only a motor is to be judged on the basis of the volt-amperes rating of the motor. A component that controls loads in addition to the motor is similarly to be judged on the basis of the sum of the volt-amperes rating of the loads controlled. However, a component that independently controls separate loads is to be judged on the basis of the volt-amperes rating of the larger load. The volt-amperes values for all loads are to be determined by the measured input.

38.3 All uninsulated live parts connected to different circuits, except subdivided circuits or branch circuits of the same voltage from the same feeder, shall be spaced from one another as though they were parts of opposite polarity in accordance with Table 38.1 and are to be evaluated on the basis of the highest voltage involved.

38.4 The spacing requirements in Table 38.1 do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component that is evaluated on the basis of the requirements for the component. However, the electrical clearance resulting from the installation of a component (this includes clearances to dead metal or enclosures) shall be as specified in Table 38.1.

39 Low-Voltage Circuits

39.1 Where operation of the product in a short- or grounded-circuit may result in risk of fire, electric shock or injury to persons, spacings for low-voltage electrical components that are installed in a circuit that includes a motor-overload protective device, or other protective device, shall comply with the requirements of 39.2 – 39.5.

39.2 The spacing between an uninsulated live part and the wall of a metal enclosure including fittings for the connection of conduit or metal-clad cable shall be greater than or equal to 1/8 inch (3.2 mm). See 38.3.

39.3 The spacing between wiring terminals, regardless of polarity, and between the wiring terminal and a dead metal part (including the enclosure and fittings for the connection of conduit) that may be grounded when the device is installed shall be greater than or equal to 1/4 inch (6.4 mm).

39.4 The spacing between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part (other than the enclosure) that may be grounded when the device is installed shall be greater than or equal to 1/32 inch (0.8 mm), provided that the construction of the parts is such that spacings will be maintained in intended use of the product.

39.5 The spacings in low-voltage circuits that do not contain devices such as those indicated in 39.2 are not specified.

PERFORMANCE

40 General

40.1 A furnace shall comply with the applicable requirements when tested as described herein. A furnace of a type not described specifically herein is to be tested in accordance with the intent of these requirements.

40.2 A supplementary furnace intended for installation in conjunction with a gas- or oil-fired central furnace is to be tested in conjunction with one or more representative central furnaces. A representative furnace is considered to be one whose operation is most likely to be affected by the installation of the supplementary furnace when factors such as temperature rise, air delivery, and continuity of operation are examined.

40.3 A furnace is to be tested for installation on noncombustible floors and in a position providing clearances to combustible walls and ceilings as specified in Table 40.1. At the option of the manufacturer, a furnace may be tested for installation on combustible floors.

Table 40.1
Standard clearances

Minimum clearance, inches (mm)				
A	B	C	D	E
Above	Front	Connector	Rear	Sides
18 (460)	48 (1220)	18 (460)	18 (460)	18 (460)

40.4 At the option of the manufacturer a furnace may be tested with clearances other than those specified in Table 40.1. However, clearances from a chimney connector shall be greater than or equal to 18 inches (460 mm).

40.5 Use of the clearances specified in Table 40.1 assumes that the furnace is being installed in a room that is large compared to the size of the furnace. All clearances designated in Table 40.1 or designated by the manufacturer under an option are to be given in integral inches for testing purposes.

TEST INSTALLATION FOR CENTRAL FURNACES

41 Enclosure

41.1 The furnace in the as-received condition is to be placed in a partial enclosure as specified in 41.2 – 41.4. The distances from the back, side, and top of the furnace and from the chimney connector to the walls and ceiling of the enclosure are to be as indicated in Table 40.1. If one side of the furnace may create higher wall temperatures than the other, that side of the furnace is to be directly opposite one wall.

41.2 The furnace is to be level. Leveling means are to be removed if detachable; or, if not detachable, they are to be adjusted to place the base of the furnace at the minimum allowable distance above the floor.

41.3 The partial enclosure is to be formed by two walls of wood boards that are trade-size 1 inch [nominal 3/4 inch (19 mm)] thick or plywood that is 3/4-inch thick, set at right angles and finished in flat black. See Figure 41.1. A ceiling of equivalent construction is to be placed above the partial enclosure. The height of the walls is to provide the minimum clearance above the furnace specified in Table 40.1. All joints in the test enclosure are to be tight or sealed. The walls and ceiling of the partial enclosure are to extend 3 feet (0.91 m) beyond the end and side of the furnace. The walls are to be at the minimum distance specified in Table 40.1 from the side and back of the furnace. However, when the flue outlet is horizontal, the wall opposite the flue collar is to be at the specified distance from a vertical chimney connector as connected to the flue collar by a 90-degree elbow. See 42.1.