44.20 A coupling or union which is disconnected for service shall be located so that any oil dripping from the connection will not drip or run onto electrical parts.

44.21 A 1/8 inch (3.18 mm) iron pipe size or larger plugged tapping, accessible for test gauge connection, shall be furnished downstream from the last main line gas control for measuring gas pressure at the burner.

45 Valves and Regulators

45.1 Automatic safety shutoff valves – General

45.1.1 The pressure rating of a valve shall be not less than the maximum operating pressure of the fuel-burning device.

45.1.2 Safety shutoff valves shall be constructed so that they may not be restrained or blocked in the open position. Such valves shall close upon being de-energized regardless of the position of damper operating lever or reset handle.

45.1.3 An electrically operated safety shutoff valve shall not depend on electricity to shut off the fuel flow.

45.1.4 A pressure operated safety shutoff valve shall close upon failure of pressure.

45.1.5 A bypass to provide for minimum flame may be installed around a valve used to regulate fuel input only. A bypass shall not be installed around a safety shutoff valve or a combination input control and safety shutoff valve.

45.2 Oil valves

45.2.1 An automatic oil safety valve shall have a shut off time not to exceed that shown in Table 55.1 after being de-energized.

45.2.2 The oil fuel train of each assembly having an input in excess of 3 gph (11.4 L/h) shall be provided with two oil safety shut-off valves or one safety shut-off valve and a nozzle cut-off valve. The closing times of the shut-off valves shall not exceed the timings specified in 45.2.1. The pressure rating of the shut-off valves shall not be less than the maximum pump pressure.

45.2.3 A safety shut-off valve that is responsive to pressure variations in a hydraulic or pneumatic remote control system shall close upon failure of pressure in the control system.

45.3 Gas valves

45.3.1 Each main burner supply line shall be equipped with a safety shutoff valve or valves which will close, independent of external force and with sufficient closing force to provide tight shutoff under normal operating conditions. The following arrangements comply with this requirement:

a) Either two valves in series, one of which is a safety shutoff valve, or one safety shutoff valve of the type incorporating a proof of closure switch, when the maximum firing rate per combustion chamber does not exceed 2,500,000 Btu per hour (732 Kw). The two valve arrangement may be incorporated into a single control body;

b) Two safety shutoff valves in series, or one safety shutoff valve of the type incorporating a proof of closure switch, when the maximum firing rate per combustion chamber exceeds 2,500,000 Btu per hour but is not more than 5,000,000 Btu per hour (1.46 MW); or

c) Two safety shutoff valves in series, one of which is of the type incorporating a proof of closure switch when the maximum firing rate per combustion chamber exceeds 5,000,000 Btu per hour. Burners having a maximum firing rate per combustion chamber in excess of 12,500,000 Btu per hour and equipped to fire fuel gas having a specific gravity less than one shall also include a normally open 3/4 inch (19.1 mm) or larger electrically operated valve in a vent line located between the two safety shutoff valves.

Exception: If an automatic valve proving system is installed to verify that both safety shutoff valves are leak-free during each burner cycle and functions to prevent light-off in the event of a leak, a normally open vent valve is not required to be used.

45.3.2 Each pilot supply line shall be equipped with a safety shutoff valve. This may be incorporated into a main line combustion gas valve.

45.3.3 Gas safety shutoff valves shall shut off after being de-energized within the time limits specified in Table 55.1.

45.3.4 Means shall be provided to facilitate testing automatic gas valves for leakage when in the closed position.

45.3A Automatic valve proving systems

45.3A.1 When an automatic valve proving system is utilized, it shall comply with the requirements of 45.3A.2 – 45.3A.5, as applicable.

45.3A.1 added August 13, 2012

45.3A.2 Valve proving is to be verified by a pressure operated switch, or a pressure sensor and controller complying with the requirements of the Standard for Limit Controls, UL 353 or the requirements for protective controls in the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1, General Requirements, UL 60730-1. The pressure-operated switch shall be of the automatic reset type, suitable for use with the type of gas marked on the rating plate, and have an operating pressure range adequate to perform the valve proving check feature of the system.

45.3A.2 added August 13, 2012

45.3A.3 Automatic valves utilized with the operation of an automatic valve proving system shall be verified as having an opening time adequate to perform the valve proving check feature as specified in 45.3A.4 and shall comply, as applicable, with the time limits of Table 55.2.

45.3A.3 added August 13, 2012

45.3A.4 It shall be verified following assembly, that the valve opening time of the electric gas safety shutoff valves, as required by 45.3.1, is adequate to perform the valve proving check feature for the gas volume between the two valves.

45.3A.4 added August 13, 2012

45.3A.5 A bypass valve shall not be installed in parallel with the automatic safety shutoff valves for the purpose of filling or evacuating the main gas supply piping during the valve proving test, unless it can be verified, by test and/or a review of the wiring schematic of the unit, the bypass valve cannot be energized during a call for heat.

45.3A.5 added August 13, 2012

45.4 Manually operated valves – Oil

45.4.1 A manually-operated fuel-metering valve shall be provided with a means that may be set by the installer or manufacturer to restrict the maximum amount of fuel delivered to the burner to an amount which can be consumed as intended, or the means for adjustment shall be enclosed or shielded to discourage tampering after adjustment has been made by the installer. This does not apply to a burner intended only for commercial or industrial installations not open to the public.

45.4.2 A plug or rotating-disc type valve, employing the bearing surface of the plug or disc as the liquid seal to the exterior of the valve body, shall not be used in a fuel oil line.

45.4.3 A petcock or valve which, when open, will permit the discharge of fuel oil into the room shall not be used.

45.5 Manually operated valves – Gas

45.5.1 Manually operated main shutoff and pilot shutoff valves shall have an attached handle which is positioned parallel to the gas flow when the valve is in the open position. These valves shall be located so that they are accessible. These valves shall be stamped and/or marked for their specifically designed use (such as ″g″ for gas, or ″wog″ for water, oil, or gas), and they shall have indicated ON and OFF positions. These indications may be by means of a line on the valve stem which is parallel to the flow of gas when the valve is open and perpendicular to the flow of gas when the valve is closed. The valve shall also incorporate stops for both fully open and fully closed positions.

45.5.1 effective January 30, 2009

45.5.2 A manually operated main burner shutoff valve shall be installed in the line supplying all main burners of each gas device and shall be located upstream of main burner gas control and automatic safety shutoff valves. Another manually operated gas valve shall be installed in the gas line of the main burner, located downstream of all automatic safety shutoff valves to permit the testing of the safety shutoff valves for leakage.

45.5.3 A manually operated pilot shutoff valve shall be located in the gas supply line to the pilot burner(s).

45.6 Pressure regulators – Oil

45.6.1 A pressure-regulating valve shall incorporate a means of shielding or locking the adjustment to discourage tampering by unauthorized persons after being set. The valve shall be constructed so that the maximum pressure of oil at the maximum valve setting will not exceed the intended maximum pressure for the burner.

45.6.2 A nozzle shutoff valve of the automatic type shall close at a pressure above the minimum atomizing pressure of the burner.

45.6.3 A pressure-relief valve shall be connected into a fuel line in which pressure may build up in excess of that intended by the design, because of the closing of any valve in the assembly of the burner or when the oil is heated by a preheater.

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45.7 Pressure regulators – Gas

45.7.1 Spring or weight loaded regulators shall have springs or weights covered by a housing. A weight and lever type of regulator shall not be used.

45.7.2 The diaphragm housing of a gas pressure regulator shall be made so that a vent pipe may be connected. See Marking, 36.8, for tagging of vent line connection.

Exception: When the gas pressure regulator is provided with an integral leak limiting orifice, the vent pipe connection and marking of the connection need not be provided.

45.7.3 Except as indicated in 45.7.4, a gas pressure regulator(s) shall be furnished.

45.7.4 A burner or device may be furnished without a pressure regulator provided it is permanently marked to declare that a regulator capable of being adjusted to the equipment's designed burner manifold pressure shall be installed at the time of installation of the equipment. See 36.10.

46 Stuffing Boxes

46.1 If packing is used to prevent leakage of fuel oil around a shaft or stem, a stuffing box conforming to 46.2 – 46.11 shall be used if the construction is such that it is necessary to adjust or renew the packing to prevent leakage during usage or as wear occurs.

46.2 A stuffing box shall be provided with a removable, shouldered, unthreaded follower gland and with a nut, spring takeup, or equivalent means for adjusting the gland to maintain pressure on the packing as wear occurs.

46.3 A stuffing box for an automatically-operated stem shall be constructed to avoid binding of the stem.

46.4 If an adjustable stuffing box is used to seal an automatically-actuated stem of a safety device, it shall be such that any allowable adjustment of the packing take-up will not bind the stem sufficiently to prevent the device from functioning automatically. A gland shall be spring-loaded.

46.5 An automatic spring take-up for a gland shall employ a spring made of corrosion-resistant material or one coated to retard corrosion.

46.6 The physical characteristics of a take-up spring shall be such that it will advance the gland through not less than one-half its possible travel from its initial setting with the spring compressed.

46.7 At the advanced position of the gland, a take-up spring shall not require adjustment of the nut to prevent leakage from the stuffing box when tested under pressure of one and one-half times maximum rated pressure.

46.8 A stuffing-box gland shall be made of corrosion-resistant material. The assembly of parts shall be such as to result in compressing the packing against the stem when the stuffing box nut or yoke is tightened.

46.9 Before shipment, a stuffing box shall be fully packed with pliable packing material, the impregnation of which is not adversely affected by contact with fuel oil.

46.10 The structure shall be such as to permit repacking the stuffing box without requiring the assembly to be dismantled, and threads of a stem shall not enter the stuffing box recess.

46.11 A manually-operated stem shall not back out, nor shall threads of a stem enter a stuffing-box recess, when the stem is rotated or reciprocated in any allowable manner even though an adjustable packing nut or other take-up is disengaged.

47 Bleeds and Vents

47.1 A bleed line from a diaphragm valve and an atmospheric vent line from a gas-pressure regulator, pressure interlock switch or any other gas train component that requires atmospheric air pressure to balance a diaphragm, shall be provided with threaded pipe connection for venting in accordance with the manufacturers instructions. Unless the burners are equipped for constant-burning pilot only, the vent line of a regulator shall not vent into the combustion chamber. Bleed lines shall be not less than 1/4 inch (6.4 mm) outside diameter tubing.

47.2 Bleed lines from diaphragm control valves and vent lines from gas-pressure regulators that vent into the combustion chamber shall terminate in burner tips made of a metal having a melting point in excess of 1450°F (788°C). They shall be located so that the escaping gas will be readily ignited from the pilot flame and the heat liberated will not impair the operation of the thermal element. Bleed line burners shall be securely held so that the ports are in a fixed position relative to the pilot flame.

47.3 A vent line from a gas-pressure regulator shall not be connected into a common line with a bleed line from a gas-operated diaphragm or from a relief valve.

47.4 Atmospheric vent lines, when manifolded, shall be connected to a common vent line having a cross sectional area not less than the area of the largest vent line plus 50 percent of the areas of all the additional vent lines.

47.5 Gas vent lines with normally open, fully ported, electrically operated valves shall be sized in accordance with Table 47.1.

Table 47.1
Vent line sizing

Fuel line size, nominal pipe size, inches	Vent line size, nominal pipe size, inches
Up to 1-1/2	3/4
2	1
2-1/2	1-1/4
3	1-1/4
4	2
5	2
6	2-1/2
8	3

48 Gauges

48.1 A pressure gauge, when used, shall have a scale range of at least one and one-half times the maximum intended operating pressure of the burner and greater than the maximum operating pressure as well as the pressure obtained at the maximum setting of any relief or pressure-regulating valve included as part of the burner equipment.

48.2 A glass gauge or sight feed, the breakage of which will allow the discharge of fuel oil from the fuel supply system, shall not be used.

49 Ignition Systems – General

49.1 The electric igniter, pilot burner, and pilot and main burner flame-sensing devices shall be constructed and supported so that each will be fixed in its intended position.

49.2 The means for ignition shall be so designed and located as to avoid the collection of carbon and other material, or the dislocation, distortion, or burning of parts when the burner assembly is tested in accordance with these requirements.

49.3 The construction of a burner assembly shall be such that the igniter assembly may be readily withdrawn from and replaced in the burner assembly during servicing of the igniter assembly and burner assembly without resulting in:

a) Reduction of the clearances between bare current carrying parts, electrodes, and grounded metal parts;

b) Changes in the air gap at electrode tips;

c) Reduction of the spacings between the high potential cables and grounded metal parts; or

d) Changes in the position of the igniter or pilot relative to the area at which ignition is to be initiated.

50 Oil-Burning Devices

50.1 Except as indicated in 50.2, the lighting of main burner flame shall be accomplished by a pilot flame. An electric ignition system shall ignite only a pilot.

50.2 For an automatically ignited mechanical draft oil burner, having a maximum main flame hourly input in excess of 20 gph (75.7 L/h) the lighting of the main burner flame may be accomplished directly by an electric igniter if the burner is arranged to provide a guaranteed low fire start at a fuel input not exceeding 20 gph (75.7 L/h). The device shall carry the supplementary marking indicated in 36.24.

50.3 The high tension electric ignition system of an automatically-lighted oil burner shall be activated only before or simultaneously with the delivery of fuel to the ignition zone and shall remain active during the trial-for-ignition period. See 4.113.

51 Gas-Burning Devices

51.1 Except as indicated in 51.2, the lighting of the main burner flame shall be accomplished by a pilot flame. An electric ignition system shall ignite only a pilot.

51.2 For an automatically ignited mechanical draft gas burner having a maximum firing rate not greater than 5,000,000 Btu per hour per combustion chamber, the lighting of the main burner flame may be accomplished directly by an electric igniter if the burner, in conjunction with the appliance on which it is used, complies with Delayed Ignition – Test No. 10, 64.10.1 – 64.10.3. However, the maximum fuel input that is ignited directly by an electric igniter shall not exceed 2,500,000 Btu per hour. See 51.3.

51.3 If the maximum firing rate of a gas burner on which the main burner flame is lighted directly by an electric igniter exceeds 2,5000,000 Btu per hour per combustion chamber, the initial ignition input shall not exceed 2,500,000 Btu per hour. The ignition input shall be controlled by one or more of the following arrangements:

a) A low-fire start-up proved by an interlock arrangement;

b) A slow-opening gas valve arranged so that in 5 seconds after the valve is energized the fuel input rate to the burner does not exceed 2,500,000 Btu per hour; or

c) Staged fuel input by either a step-opening valve or an arrangement of two separate valves (see 45.1.5). The second stage input shall be delayed not less than 5 seconds from the energization of the first stage.

51.4 The ignition system for the main burner shall be activated before the delivery of fuel to the ignition zone and shall remain active during the main burner flame-establishing period. If means for ignition is cut off at the termination of the main burner flame-establishing period, the ignition (pilot and any pilot or main flame electric igniter) shall remain off for the duration of that firing cycle and for the purge period required upon attempting the next firing cycle in accordance with 55.3.

52 Electric High-Tension Ignition

52.1 Spark igniters

52.1.1 Current carrying parts, such as a bus bar, electrode, or terminals, shall be enclosed or insulated to provide protection against accidental contact.

52.1.2 If an adjustable air deflector or similar part is employed in the vicinity of bare conductors, the construction shall be such that the part may be securely fixed to maintain any spacing required to conform to 52.2.2.

52.1.3 The ignition system shall be subjected to the test specified in 31.2.1 and 31.2.2.

52.2 Electrode and bus bars

52.2.1 Bare electrodes and bus bars shall be self-supporting when in place.

52.2.2 An electrode or bus bar supporting an electrode shall be designed so that it may be fixed in its proper position, and will maintain the desired gap.

52.2.3 A setscrew shall not bear directly against an insulator. The design shall be such that an insulator is not likely to be damaged when tightening the securing means.

52.2.4 An electrode shall be prevented from rotating within its insulator, unless such rotation will not result in any change in spacing or alignment.

52.2.5 An electrode tip shall be of such design and material that extreme burning of its point will not result when the burner is tested in accordance with these requirements. A high-temperature alloy steel, or equivalent material, shall be used for the electrode tip.

52.2.6 An electrode slanting downward toward its insulator shall be provided with a drip loop, or the equivalent, to prevent oil running down the electrode from reaching the insulator.

52.3 Insulators

52.3.1 An insulator shall be made of ceramic insulating material or the equivalent, impervious to oil and moisture and cleanable by wiping. See 31.3.1 and 31.3.2 for the test method to confirm conformance with this clause.

52.3.2 An insulator shall provide a distance, as measured across the surface of the insulator, between the nearest point of bare current carrying parts and the nearest electrically grounded metal surface as indicated in Table 52.1.

Table 52.1
Spacing over surface of insulators

Secondary voltage of ignition transformer	Minimum surface distance over insulator, inches (mm)
Not more than 6,000	1 (25.4)
Not more than 10,000	1-1/2 (38.1)
Not more than 15,000	2 (50.8)

52.3.3 An insulator included in a proved gas pilot assembly to be energized by a transformer having a secondary voltage of not more than 6,000 need not conform to 52.3.2 and Table 52.1 if ignition is to be for combustible air-gas mixtures only within or adjacent to a pilot tip or nozzle.

52.3.4 An insulator shall be so located that no detrimental accumulations of carbon will form on it when the burner is tested in accordance with these requirements.

52.4 Leads

52.4.1 Ignition cable shall have a voltage rating equal to or greater than the rated secondary voltage of the ignition transformer. Each end of a high-tension lead shall be provided with a fixed loop, eyelet, or connector to facilitate and make sure adequate connection to the terminal. A high-tension lead or cable shall be run individually in a manner to avoid sharp bends.

52.5 Transformers

52.5.1 A transformer shall be mounted as closely as possible to the spark gap to avoid long leads. Its location shall be such that it will not be placed within 1 inch (25.4 mm) of the floor when the burner assembly is installed in accordance with the manufacturer's installation instructions unless that portion of the case within 1 inch (25.4 mm) of the floor is waterproof.

52.5.2 A spacing of at least 1/8 inch (3.2 mm) shall be provided between a transformer secondary terminal insulator and any adjacent metal part other than the transformer case.

52.5.3 The preceding requirements for electric high-tension ignition systems are based upon the use of ignition energy that is essentially sinusoidal. Other types of systems employing ignition energy that is not essentially sinusoidal may be considered. Among the factors taken into consideration in determining the acceptability of such systems are dielectric properties, electrical spacings, the true root-mean-square (rms) value and the peak voltage of the system, the average pulses, duration of the pulses, and duty cycles.