

## Section

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7.01: Definitions

Air Shutter. An adjustable device for varying the size of the air inlet or inlets regulating primary or secondary air.

Boiler. See NFPA 85, subsection 3.3.20

Breeching. (See Chimney Connector.)

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

- (a) Injection (Bunsen) Type Burner. A burner employing the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.
- (b) Atmospheric Injection Type Burner. A burner in which the air at atmospheric pressure is injected into the burner by a jet of gas.
- (c) Luminous or Yellow Flame Burner. A burner in which secondary air only is depended on for combustion of the gas.
- (d) Power Burner. A burner in which either gas or air or both are supplied at pressures exceeding, for gas, the line pressure and, for air, atmospheric pressure; this added pressure being applied at the burner. A burner for which air for combustion is supplied by a fan ahead of the appliance is commonly designated as a forced draft burner.
- (e) Premixing Burner. A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.
- (f) Induced Draft Burner. A burner which depends on the draft induced by a fan beyond the appliance for its proper operation.
- (g) Pressure Burner. A burner which is supplied with an air-gas mixture under pressure (typically from 0.5 to 14.0 inches of water and occasionally higher).

Burner Head That portion of a burner beyond the outlet end of the mixer tube which contains the ports.

Burner, Automatically Lighted. One where fuel to the main burner is normally turned on and ignited automatically.

Burner, Manually Lighted. One where fuel to the main burner is turned on only by hand and ignited under supervision.

Chimney. A vertical shaft enclosing one or more flues for conveying flue gases to the outside atmosphere.

- (a) Factory-built Chimney. A listed chimney.
- (b) Masonry Chimney. A chimney of solid masonry units, bricks, stones, listed masonry chimney units or reinforced concrete, lined with suitable flue liners.
- (c) Metal Chimney. A field-constructed chimney of metal.

Chimney Connector. The pipe which connects a fuel-burning appliance to a chimney.

Combustion. The rapid oxidation of fuel gases accompanied by the production of heat or heat and light.

Combustion Control. A control which automatically regulates the firing rate at predetermined air-fuel ratios in accordance with load demand.

- (a) High-low Firing. The action of a combustion control which positions the air and fuel supply for low-fire and for high-fire in accordance with load demand.
- (b) Modulating. The action of a combustion control which gradually varies the air and fuel supplies within limits in accordance with load demand.

Combustion (Input) Control Valve. An automatic gas-control valve for regulating equipment input.

Combustion Products. Constituents resulting from the combustion of a fuel gas with the oxygen of the air, including the inerts, but excluding excess air.

Condensate. The liquid which separates from a gas (including flue gases) due to a reduction in temperature.

Controls. Devices designed to regulate gas, air, water or electrical supply to equipment. These may be manual, semi-manual, semi-automatic or automatic.

Control, Limit. An automatic control responsive to changes in liquid level; in fuel, steam or air pressure; in air, gas or liquid flow; or in temperature; for limiting the operation of the controlled equipment.

Control, Primary Safety. A control responsive directly to flame properties; sensing the presence of flame and causing fuel to be shut off in the event of ignition or flame failure requiring manual reset.

Control, Safety. Automatic controls and interlocks (including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety control system which are intended to prevent unsafe operation of the controlled equipment).

Damper. A valve or plate for controlling draft or flow of the flue gases. A damper is generally considered as being located on the downstream side of the combustion chamber usually in a flue passage of the appliance or in the chimney or vent connector.

Damper, Automatically Operated. A damper operated by an automatic control.

Damper, Manually Operated. An adjustable damper manually set and locked in the desired position.

Draft Regulator, Barometric. A device which functions to maintain a desired draft in the appliance by automatically reducing the chimney draft to the desired value.

Equipment. Any gas utilization equipment having inputs of more than 400,000 BTU's per hour per combustion chamber. This includes, but is not limited to, steam boilers, hot water boilers, water heaters, generators, and other similar gas utilization equipment.

Flame Safeguard. (*See Control, Primary Safety.*)

Flue Gases. Products of combustion and excess air.

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

Labeled. Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials and by whose labeling is indicated compliance with nationally recognized standards or has been tested and found safe for use in a specified manner.

Listed. Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspections of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found safe for use in a specified manner.

Low-fire Start, Proven. The firing of a burner with fuel and combustion air controls interlocked in a low-fire position to provide safe operating conditions during light off.

Lubricated Plug-type Valve. A valve of the plug-and-barrel type designed for maintaining a lubricant between the bearing surfaces.

Main Burner Flame-establishing Period. The length of time the main burner flue safety shutoff valves are permitted to be open before the flame sensing device is required to supervise the main burner flame.

Optimum Air-fuel Ratio. A ratio of air to fuel going to the furnace which will provide complete combustion of the fuel with sufficient range of excess air to maintain a stable flame envelope.

Pilot. A flame which is utilized to ignite the gas at the main burner or burners.

Pilot, Continuous. A pilot that burns without turndown throughout the entire time the burner is in service, whether the main burner is firing or not.

Pilot, Expanding. A continuously burning pilot that is automatically expanded so as to reliably ignite the main burner. This pilot may be turned down at the end of the main burner flame-establishing period.

Pilot Flame-establishing Period. The length of time fuel is permitted to be delivered to a proved pilot before the flame sensing device is required to detect pilot flame.

Pilot, Intermittent. A pilot which is automatically lighted each time there is a call for heat. It burns during the entire period that the main burner is firing.

Pilot Interrupted. A pilot which is automatically lighted each time there is a call for heat. The pilot fuel is cut off automatically at the end of the main burner flame-establishing period.

Pilot, Proved. A pilot flame supervised by a primary safety control.

Purge. To free a gas conduit of air or gas, or a mixture of air or gas.

Regulator, Gas Pressure. An automatic gas pressure reducing device for the purpose of maintaining a uniform gas supply pressure.

Safety Shutdown. The action of shutting off all fuel and ignition energy to the appliance by means of a safety control or controls such that restart cannot be accomplished without manual reset.

Safety Shutoff Valve. A gas-control valve that is automatically closed by the safety control system or by an emergency device. The valve may be of the automatically or manually opened type.

Throttling. (See "Modulating" under Combustion Control.)

Trial-for-ignition Period. (See Main Burner Flame-establishing Period.)

Zero Governor. A regulating device which is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

## 7.02: General Provisions

(1) Before arranging for the selection or installation of large gas equipment, the licensed plumber or gas fitter shall check with the serving gas supplier as to the availability of gas, specifying the gas input rating and the gas pressure required at the entrance to gas train. (See Figure 3 in 248 CMR 7.03).

(2) Combustion Air Supply and Ventilation.

(a) General.

1. Positive means for supplying an ample amount of outside air to permit combustion of the gas shall be provided. Automatic or manually adjustable control devices for outside air intake shall be interlocked with the burner.
2. To determine air requirements at the equipment, under standard atmospheric conditions (60EF and 30 inches mercury), the following minimum factors apply:
  - a. For equipment with draft hoods - 30 cubic feet per 1000 Btu input;
  - b. or equipment directly connected to a chimney without neutralizing air openings - 12 cubic feet per 1000 Btu input.
3. When equipment is located in an inside room or space, air supply shall be provided through ducts or openings leading to the outside air.
4. Openings to the outside shall be unobstructed and screens, if used, shall have a minimum of ½ inch mesh.
5. When a room or space in which equipment is installed is ventilated by mechanical means, air sufficient to replace that exhausted and consumed by combustion shall be supplied from a safe, uncontaminated source. The means for ventilation shall not create an unsafe pressure condition in the boiler room.
6. In addition to the combustion air required, sufficient air shall be supplied to the room to make the room safe for occupancy and proper operation of equipment.

(b) Equipment Equipped with Draft Hoods.

1. The effective cross-sectional area of the permanent outside air opening(s) to the room where equipment is located shall be large enough to supply the air required in that room.
2. For supplying combustion air, the area of the opening shall be of a size at least equal to the equipment breeching but not less than one square inch of free area per 5,000 Btu per hour input (approximately equal to 1.4 square feet per million Btu), except as noted in 248 CMR 7.02(2)(e).

(c) Equipment utilizing Barometric Dampers.

1. The effective cross-sectional area of the permanent outside air opening(s) to the room where the equipment is located shall be large enough to supply the air required in that room.
2. For supplying air, the area of the opening shall be of a size at least equal to the equipment breeching but not less than one square inch of free area per 14,000 Btu per hour input (approximately equal to 0.5 square foot per million Btu), except as noted in 248 CMR 7.02(2)(e).

(d) Equipment Directly Connected to Chimney without Neutralizing Air Openings.

1. The effective cross-sectional area of the permanent outside air opening(s) to the room where the equipment is located shall be large enough to supply the air required in that room.
2. For supplying air, the area of the opening shall be of a size at least equal to the equipment breeching but not less than one square inch of free area per 17,500 Btu per hour input (approximately equal to 0.4 square foot per million Btu), except as noted in 248 CMR 7.02(2)(e).

(e) Exceptions.

1. Ducts to a Room where equipment is located: In determining the cross-sectional area of duct(s) used to convey air from the outdoors to the boiler room, the resistance to air flow imposed by the duct(s) shall be considered.
2. Forced Air Supply to a Room where equipment is located: If mechanical means for room air supply are used, the size of the duct or opening may be reduced to not less than that needed to provide the required quantity of air.

(3) Accessibility for Cleaning and Inspection. Sufficient and reasonable accessibility shall be offered for inspection, cleaning, repair and replacement of all burners, combustion controls, safety devices and boiler components.

(4) Venting of Flue Gases.

(a) Chimneys.

1. All equipment shall be securely connected to a chimney in good condition and of proper construction and ample size to carry away the flue gases and permit satisfactory burner operation under all weather and operating conditions.
2. The chimney shall be designed and built to sufficiently remove the maximum volume of flue gases which may be produced by the equipment connected to it, as well as any other combustion equipment, under the least

conditions of draft which can be encountered. The design should also provide proper construction to resist wind forces, weathering, interior corrosion and flue gas temperatures.

3. The chimney shall be pre-inspected and, if necessary, tested to determine whether it is in suitable condition to handle the flue gases to be dispersed. Any defects shall be corrected.
4. An existing chimney shall be checked as to cross-sectional area, arrangement, and height to determine if it will sufficiently remove the volume of flue gases produced by the equipment, under the least condition of draft that may be encountered. This shall include consideration of pressure and temperature conditions at which the flue gases enter the chimney and the effect of flue gases which may be fed into the chimney from other combustion equipment.

(b) Chimney Connectors.

1. Connectors from equipment to a chimney shall be of noncombustible material capable of withstanding the corrosion effects and temperatures of the flue gases to be handled. They shall have sufficient strength to withstand the physical stresses likely to occur under the conditions of use and shall be securely supported.
2. The connector shall be installed so as to avoid excessive turns or other construction features which create unnecessary resistance to flow of flue gases.
3. The joint between the connector and the chimney shall be sealed to prevent gas leakage or air infiltration.
4. A connector shall not extend into a chimney beyond the inner wall of the chimney flue.
5. The connector shall be sized as recommended by the equipment or burner manufacturer. If the manufacturer's recommendations are not available, the connector shall be the size of the flue collar, or if a draft hood is used, shall be the size of the outlet of the draft hood unless the connector is designed and installed in accordance with industry recognized and approved engineering methods.
6. On multiple installations, separate connectors should be run to the chimney. When this is not practical, each connector shall be y-connected to a common breeching, the cross-sectional area of which shall be not less than the combined areas of the individual connectors.

(c) Draft Control.

1. Equipment requiring controlled chimney draft shall be capable of automatically regulating the draft as recommended by the equipment manufacturer. Such controls may be of the barometric type which regulates the draft in the breeching or the mechanically operated damper type which controls the pressure in the equipment firebox or the draft hood type which is nonadjustable.
2. A double-acting barometric draft regulator, if used, shall be equipped with a device with a manual reset which will automatically shut off the fuel to the burner in the event flue gas spillage exceeds 60 seconds.
3. Mechanically operated dampers shall be designed to maintain a safe damper opening at all times and be arranged to prevent firing of the burner unless the damper is in the proper position.
4. Draft Control:
  - a. When a draft control device is used, it shall be installed without alteration in accordance with the manufacturer's instructions.
  - b. In no case shall a barometric draft control device be installed in a false ceiling, in a different room or in any place or manner that will permit a difference in pressure between a draft relief opening and the combustion air supply.
  - c. A draft control device shall be installed in the position for which it was designed with reference to the horizontal and vertical planes and shall be located so that a relief opening is not obstructed.
  - d. When induced or forced draft devices are used, provision shall be made to prevent flow of gas to the burners upon failure of these devices.
5. Adjustable manual dampers should be removed except when a damper must be used to control excess chimney draft. Positive means shall then be provided to lock the damper in the proper position by welding or riveting. As an alternate, a portion of the damper can be removed to prevent full closure.
6. Full closing outlet isolation dampers shall be interlocked so that the boiler firing system cannot be operated unless its isolation damper is in the proper open position.
7. Adjustable (modulating) dampers, shall be arranged to maintain a safe fuel-air ratio over the full operating range. Linkage shall be arranged to resist accidental damage and disengagement. Any counter-balancing arms or weights attached to the damper shall be located or shielded as to prevent personal injury or damage to equipment in case of breakage.

8. When a draft hood is used, it shall be installed without alteration in accordance with the manufacturer's instructions. In no case shall a draft hood be installed in a false ceiling, in a different room, or in a manner that will permit a difference in pressure between the draft hood relief opening and the combustion air supply.

### 7.03: Installation of Burners and Controls

#### (1) Main Burners.

- (a) Each burner assembly and its component parts shall be installed according to the manufacturer's instructions and shall be properly and firmly secured in place to maintain correct alignment in normal use.
- (b) The burner assembly shall be installed so that sufficient accessibility is afforded for cleaning, inspection, repair, and replacement of all burners, controls and safety devices.
- (c) Burner assembly parts, when adjustable, shall be provided with suitable locking devices to prevent accidental shifting.
- (d) Provision shall be made to permit ready observation of each pilot and main burner flame during adjustment and under operating conditions.
- (e) A burner assembly, when adjusted according to the manufacturer's instruction, shall maintain satisfactory operating characteristics as specified in 248 CMR 7.04(5) at all firing rates called for by input and air-gas ratio controls applied to the installation.

#### (2) Control Application.

- (a) Each control shall be supported in such a manner that it and its sensing element will remain in proper position. It shall be possible to determine by observation or test that each control is in its proper location and capable of functioning as intended.
- (b) Nothing shall be provided for the purpose of permitting any safety control to be rendered ineffective or allowing firing of the burner assembly without the protection of all of the specified safety controls except as permitted by 248 CMR 7.03(2)(c).
- (c) A low-water cutoff may be bypassed for blow-down purposes only. Such a bypass shall be of a type which must be manually held in the bypass portion and which is self-restoring when released.
- (d) A burner assembly not equipped to provide safe automatic restarting shall be arranged to require manual restart after any control functions to cause the fuel supply to be shut off and the following restoration of an interrupted power supply.

- (e) The safety-control circuit shall be two-wire, one side grounded, having a nominal voltage of 150 volts or less. The circuit shall be connected to a branch circuit that can be protected against over current at not more than the value appropriate for the rating of the electrical components included in the circuit.
- (f) A safety control or protective device switch shall interrupt the ungrounded conductor(s).
- (g) Safety controls shall not depend on electricity to attain the off position.

(3) Control of Combustion Air.

- (a) An air shutter shall be capable of being readily adjusted to any desired setting and securely locked to prevent accidental change in setting.
- (b) The air inlet(s) shall supply an adequate amount of air for combustion under the specified draft conditions and at the maximum firing rate of the burner assembly as installed. All air required for combustion shall be introduced in a manner so as to provide thorough mixing of the gas and air. If a burner is intended for installation with an air or wind box(es), it shall be supplied by the burner manufacturer or be built in accordance with the burner manufacturer's instructions.
- (c) Linkage for controlling air and gas input rates shall be designed to reliably maintain the correct gas-air ratio and to resist accidental damage and disengagement.
- (d) Equipment having forced or induced draft fans or both, shall be provided with means to automatically continue safe combustion or to shut off the gas supply upon failure of the equipment supplying the air.
- (e) If air under pressure is mixed with the gas supply in a mixer, effective means shall be provided to prevent air from passing back into the gas line or gas into the air supply. The gas and air supply shall be controlled to prevent gas from entering burners until the air supply is available and, in the event of air failure, to shut off the gas supply.

(4) Primary Safety Control (Flame Safeguard).

- (a) Unless a flame safeguard control is provided by the manufacturer, each burner assembly shall be provided with a non-recycling primary safety control that will de-energize the main gas safety shutoff valve(s) upon loss of flame at point of supervision.
- (b) Safety control timings shall not exceed the values given in 248 CMR 7.03: *Table I*.
- (c) Gas to pilots shall be automatically shut off if the pilot is not proved, and safety shutdown established.

- (d) Pilot supervision by the primary safety control shall be only at the point where the pilot flame will effectively ignite the gas at the main burner or burner group with the pilot burning at any flame that will actuate the safety control.
- (e) Supervision of the main burner flame only shall begin at the end of the main burner flame-establishing period for:
  1. Power burners having a firing rate per combustion chamber of 2,500,000 Btu per hour and over.

TABLE 1			
Maximum Safety Control Timings			
Maximum Firing Rate Per Combustion Chamber in Million Btu Per Hour			
	2.5 or less	Over 2.5 to 12.5	Over 12.5
Pilot Flame Establishing Period	15 Seconds	10 Seconds	10 Seconds
Main Burner Flame Establishing Period (If Required)	15 Seconds *	10 Seconds	10 Seconds *
Flame Failure Response Time	4 seconds	4 Seconds	4 Seconds
Valve Closing Time	5 Seconds	1 Second	1 Second

\* Main burner flame-establishing period may be 30 seconds for burner other than power burners equipped with a safety shutoff valve having a full opening time of not less than 25 seconds.

2. All types of burners with modulating or high-low firing rate per combustion chamber of 2,500,000 Btu per hour and over.
  3. All types of burners with an interrupted pilot(s), and
  4. Atmospheric type burners having a firing rate per combustion chamber of 5,000,000 Btu per hour and over. If the main burner flame is not proved, safety shutdown shall be established.
- (f) A burner assembly shall be equipped so that no gas can flow to the main burner on burner group operating as a unit unless the pilot is proved.
  - (g) If two or more burner assemblies are installed in a single piece of equipment, the primary safety control of each burner assembly shall operate independently of the other, or equivalent safety features shall be provided so that in no case can any one burner operate unsafely.
- (5) Limit Controls.
- (a) Limit Control:

1. A limit control shall be provided to prevent excessive steam pressure in a steam boiler or excessive pressure or temperature in a hot water boiler.
  2. Each steam and hot water boiler shall be equipped with a control which will prevent firing of the boiler in the event of insufficient water in the boiler.
  3. The limit control shall be in addition to operating controls. Manual restart shall be required after a pressure or temperature limit control functions.
- (b) A limit control which functions by opening a switch shall directly open the electrical circuit to the safety shutoff valve(s).

(6) Combustion (Input) Control Systems.

- (a) The combustion (input) control system shall maintain predetermined air-fuel mixtures within the limits required by the burner for stable combustion throughout the entire operating range of the burner and during changes in the firing rate.
- (b) To accomplish changes in the firing rate, the fuel and air supplies shall be maintained at a pre-determined optimum air-fuel ratio, either manually or automatically.
- (c) Burners having a firing rate per combustion chamber of 1,000,000 Btu per hour and over shall be equipped with a proven low-fire start.
- (d) Burners having a firing rate per combustion chamber of 2,500,000 Btu per hour and over shall be provided with combustion control.

(7) Pilots.

- (a) Main burners shall be equipped with a supervised pilot adequate to provide safe main burner ignition under all conditions of operation. Multiple burner heads operated as a single burner unit shall use a sufficient number of supervised pilots to accomplish safe ignition.
- (b) A pilot burner not automatically lighted shall be located so that it can be safely lighted manually.
- (c) Gas supply pressure to the pilot or group of pilots:
  1. The gas supply pressure to the pilot or group of pilots shall be regulated.
  2. The regulator(s) shall be listed; and vented in accordance with 248 CMR 7.03(11)(c), unless constructed or equipped to limit the escape of gas from the vent opening in the event of diaphragm failure to not more than 2.5 cubic feet per hour.

3. The pilot supply line shall be connected upstream of all main burner valves and the main gas pressure regulator.
  - (d) Primary air openings and orifices shall be easily accessible for servicing.
  - (e) An electric ignition system shall ignite only a pilot.
  - (f) If means for ignition is cut off at the termination of either the main burner flame-establishing period, the ignition shall remain off for the duration of that firing cycle and for the specified purge period.
  - (g) A pilot burner, electric igniter, and pilot flame sensing device shall be supported in such a manner that their position relative to each other and to the main burner port(s) will remain fixed.
- (8) Gas Valve Pressure Ratings.
- (a) Gas valves shall be capable of withstanding without damage a pressure of not less than 10% above the relieving pressure of the nearest upstream relief device.
  - (b) In case no relief device is provided, the gas valves shall be capable of withstanding without damage a pressure of not less than the maximum inlet pressure of the nearest upstream gas pressure regulator or the maximum setting of the over-pressure protection device.
- (9) Manually Operated Gas Shutoff Valves. (See 248 CMR 7.03 Figures 1 and 2.)
- (a) A manually operated main burner shutoff valve shall be installed in the line supplying all main burners of each piece of equipment and upstream of all other main burner control valves.
  - (b) A manually operated main pilot shutoff valve shall be located in the gas supply line to the pilot burner.
  - (c) Manually operated main shutoff and pilot shutoff valves in sizes larger than two inches or for pressures greater than ½ psig shall be of the lubricated plug or ball type with stops. Manually operated valves shall have the handle securely attached parallel to the gas flow in the open position, shall be readily accessible, and shall clearly indicate the "on" and "off" positions.
  - (d) A manually operated main burner test valve (checking gas cock) shall be provided downstream from the safety shutoff valve for each main burner. On manually lighted burners, the valves shall be interlocked with the safety control circuit and arranged so that the main burner safety shutoff valves must be opened against their associated closed test valves.
  - (e) In multiple burner installations a manual valve shall be provided for each main and each pilot burner except those utilizing a single zero governor inspirator

mixer for several burners in which case this valve shall be located at a point immediately upstream of the zero governor.

- (f) Provisions shall be made so that the gas supply to equipment may be shut off from a location outside the room where said equipment is located.

FIGURE 1  
Illustration of Manual Valving Arrangement for a Multiple Burner, Single Boiler Arrangement

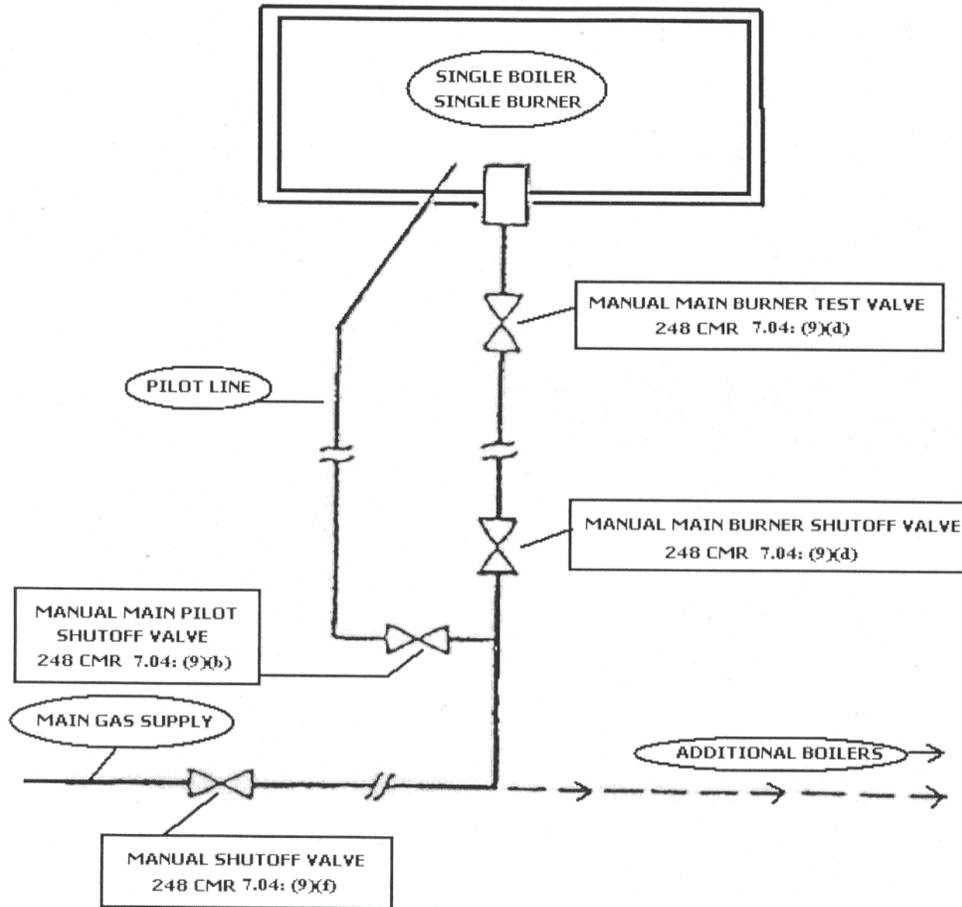
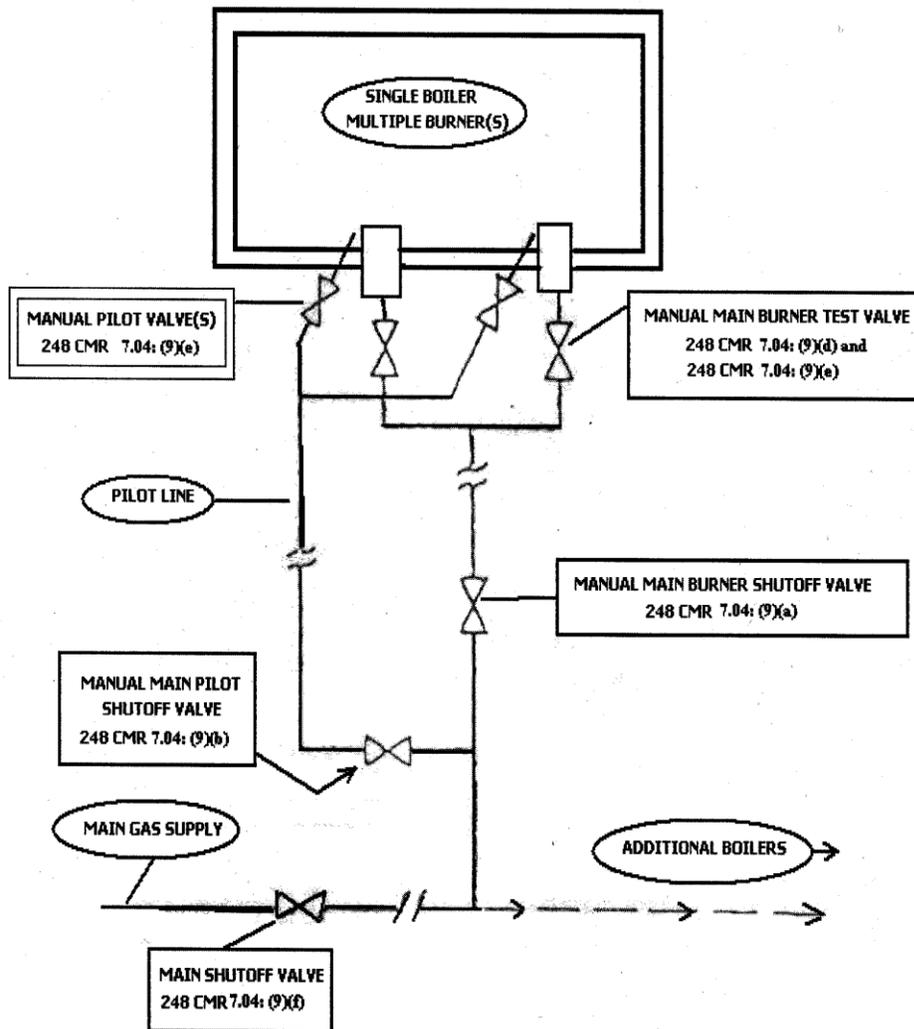




FIGURE 2  
Illustration of Manual Valving Arrangement for a Multiple Burner, Single Boiler Arrangement



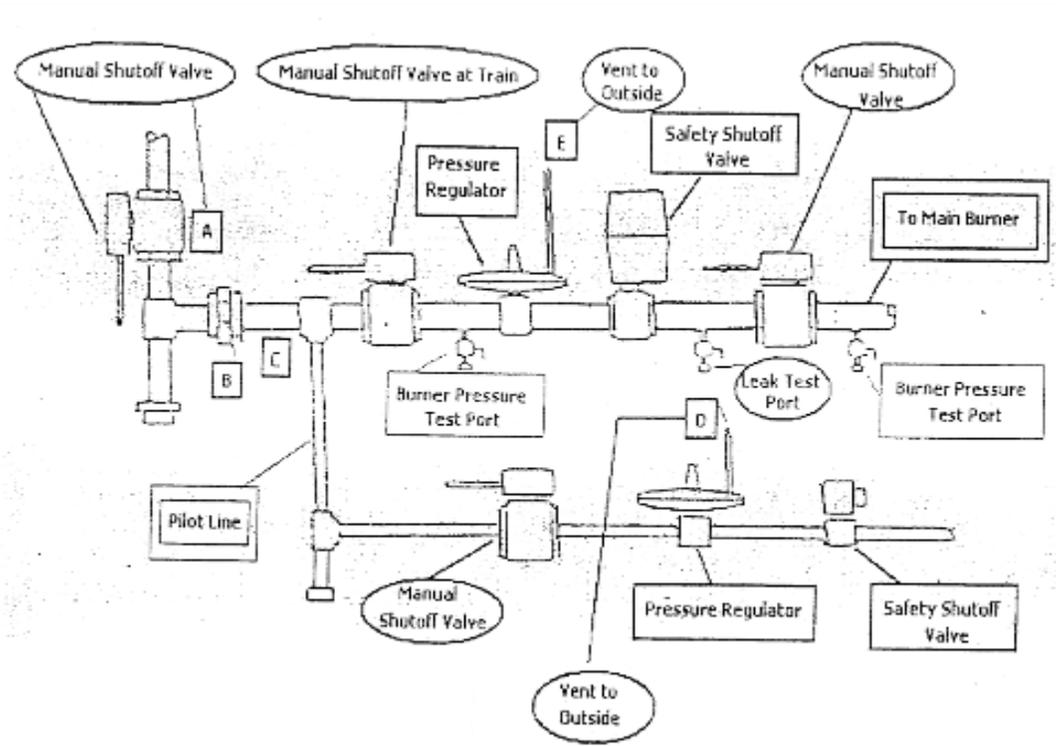
(10) Control and Safety Shutoff Valves. (See 248 CMR 7.03 Figure 3.)

- (a) An automatic input control valve may be in combination with a safety shutoff valve.
- (b) A bypass to provide for minimum flame may be installed around a valve to control input only. A bypass shall not be installed around a safety shutoff valve or a combustion input control and safety shutoff valve.
- (c) Safety Valves:
  - 1. Each main burner supply line and each pilot supply line shall be equipped with a safety shutoff valve(s) which will close independent of external force.
  - 2. The safety shutoff valve(s) shall close with sufficient force to provide tight shutoff under normal operating conditions and when closed by the safety control system or by an emergency device.
  - 3. If the maximum firing rate per combustion chamber exceeds 1,000,000 BTU/hour, the main burner supply line shall be equipped as indicated in 248 CMR 7.03(10)(c)3.a. and b.:
    - a. Two safety shutoff valves, in series, or one safety shutoff valve of the type incorporating a valve seal overtravel interlock, when the maximum firing rate per combustion chamber exceeds 1,000,000 BTU/hour but less than 5,000,000 BTU/hour.
    - b. Two safety shutoff valves, in series, one of which is of the type incorporating a valve seal overtravel interlock when the maximum firing rate per combustion chamber exceeds 5,000,000 BTU/hour. The Board may prescribe two safety shutoff valves in series, for combustion chambers with inputs less than 1,000,000 BTU/hour, in buildings of public assembly.
- (d) Safety shutoff valves shall be suitable for the application and shall have a shutoff time not to exceed that specified in 248 CMR 7.03 Table 1. They shall be constructed so that they cannot be restrained or blocked in the open position. Such valves shall close upon being de-energized regardless of the positions of damper-operating levers or reset handles.
- (e) An electrically operated safety shutoff valve shall not depend on electricity to shut off the gas supply.
- (f) A pressure-operated safety shutoff valve shall close upon failure of its operating pressure.

- (g) Permanent and ready means for making easy, accurate, periodic tightness tests of the main burner gas safety shutoff valves shall be provided in the piping.

FIGURE 3A

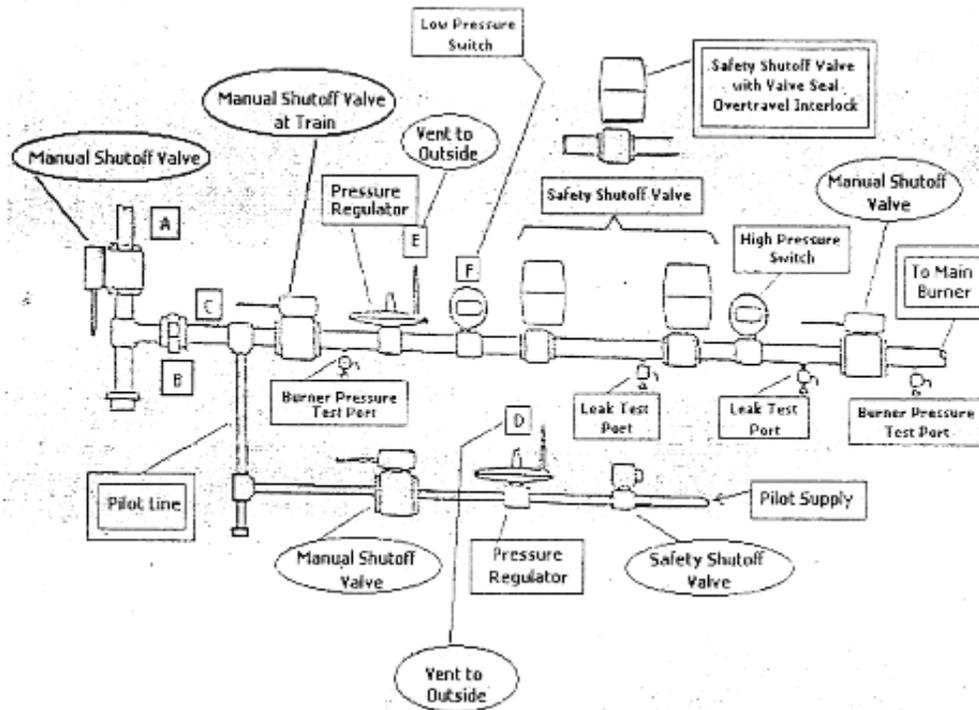
Illustration of Gas Train 248 CMR 3.00 through 7.00 requirements 400,000 to Less Than 1,000,000 BTU/hour Input



- A = Shutoff Valve Within Six Feet of Entrance to Gas Train
- B = Union
- C = Start of Gas Train
- D = Pilot Line to Outside Unless Equipped with Limiting Device of 2.5 cu. Ft/hr
- E = Vent to Outside Per Table 2

FIGURE 3B

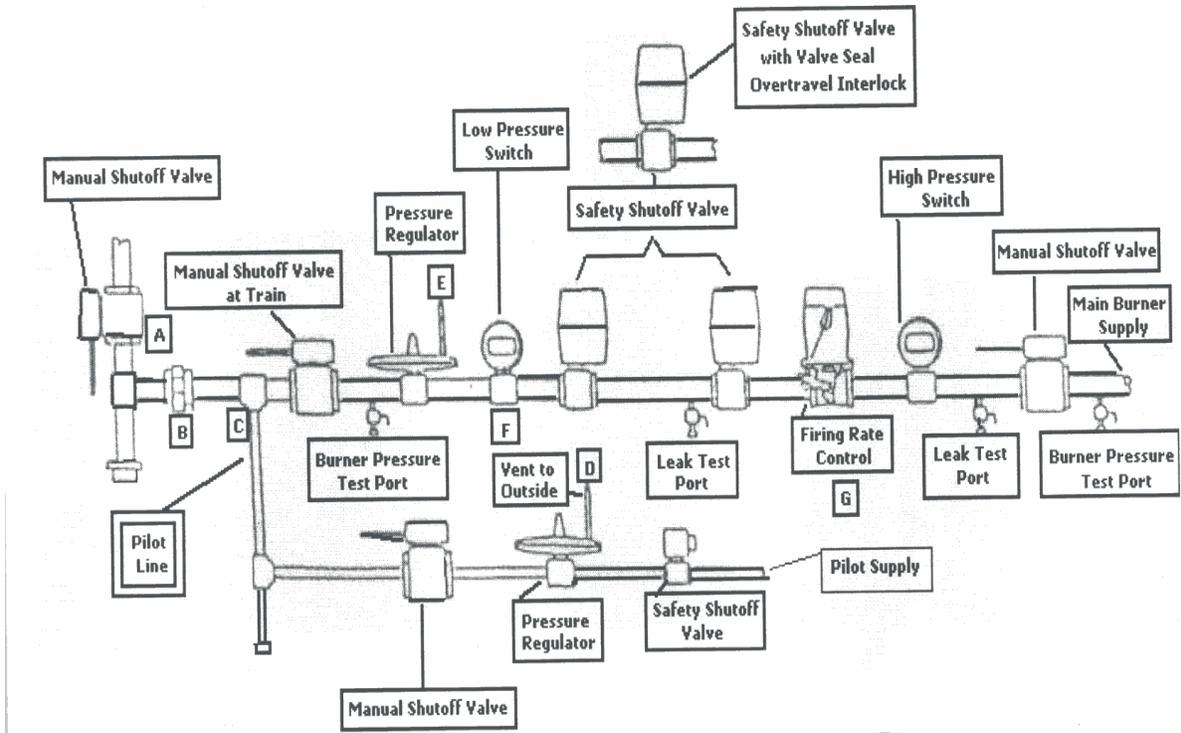
Illustration of Gas Train 248 CMR 3.00 through 7.00 1,000,000 to less than 2,500,000 BTU/hour Input



- A = Shutoff Valve Within Six Feet of Entrance to Gas Train
- B = Union
- C = Start of Gas Train
- D = Inlet Vent to Outside Unless Equipped with Vent Limiting Device of 2.5 cu. ft/hr
- E = Vent to Outside Per Table 2
- F = Combination High and Low Pressure Switch Allowed at Low Pressure Switch Location

FIGURE 3C

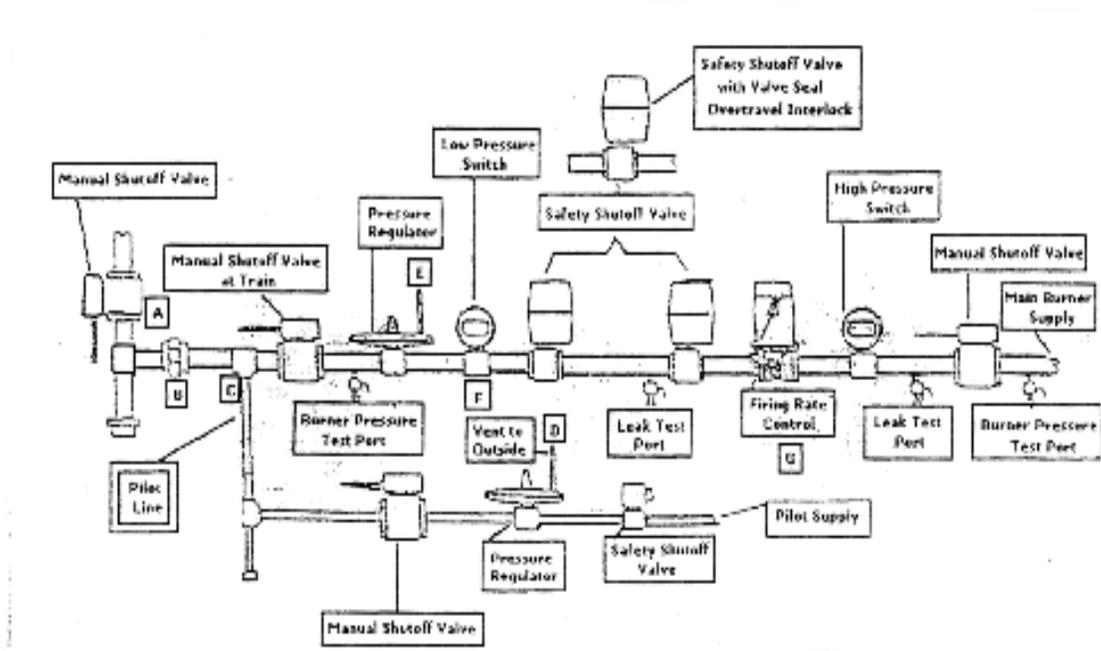
Illustration of Gas Train 248 CMR 3.00 through 7.00 requirements for 2,500,000 to less than 5,000,000 BTU/hour Input



- A = Shutoff Valve Within Six Feet of Entrance to Gas Train
- B = Union
- C = Start of Gas Train
- D = Pilot Vent to Outside Unless Equipped with Limiting Device of 2.5 cu. ft./hr
- E = Vent to Outside per Table 2
- F = Combination High and Low Pressure Pressure Switch Allowed at Low Pressure Switch Location

FIGURE 3D

Illustration of Gas Train 248 CMR 3.00 through 7.00 requirements for 5,000,000 to less than 12,500,000 BTU/hour Input



- A = Shutoff Valve Within Six Feet of Entrance To Gas Train
- B = Union
- C = Start of Gas Train
- D = Pilot Vent to Outside Unless Equipped with Limiting Device of 2.5 cu. ft./hr
- E = Vent to Outside per Table 2
- F = Combination High and Low Pressure Switch Allowed at Low Pressure Switch Location
- G = May be Part of SSOV

(11) Main Gas Pressure Regulations and Gas Pressure Interlocks.

- (a) Each burner assembly shall be equipped with a listed main gas pressure regulator that will regulate within plus or minus 10% of the operating pressure at all firing rates. (See 248 CMR 7.03 Figure 3 for Location).
- (b) Spring or weight-loaded regulators shall have springs covered by a suitable housing. Under no circumstances shall a weight and lever type or regulator be used.
- (c) Main Gas Pressure Regulators

1. Except where zero governors are used in connection with air-gas mixers, all main gas pressure shall be independently vented to a safe outdoor location.
2. Vent lines from main gas pressure regulators shall not be connected into a common line with the bleed line from gas operated diaphragm valves or from pressure relief valves.
3. Vent lines shall be steel, wrought iron pipe or corrugated stainless steel tubing (CSST) with Product-approved devices provided at termination points to prevent stoppage of the lines by foreign material, water or insects and, shall extend no less than 18inches above the roof surface.
4. Vent lines shall be sized as specified in 248 CMR 7.03 Table 2.
5. Vent lines shall be supported in accordance with 248 CMR 1.00 through 10.00.
6. Vent lines shall be run to the outside using the shortest practical route and shall not be trapped or installed in a manner that restricts air-flow.
7. Vent lines that penetrate roofs and sidewalls shall be run through metallic sleeves that are sealed from the weather and insects.
8. CSST vent lines that penetrate roofs shall transition to steel pipe no less than one foot inside the building.
9. Vent lines that terminate outside a building shall be located no less than four-feet away from any building opening or air intake and ten feet away from forced air intakes. Outside vent termination shall consist of steel pipe and malleable fittings.

(d) Pressure Switches.

1. If the maximum firing rate per combustion chamber is 1,000,000 BTU/hour or over, gas pressure supervision shall be provided by listed pressure switches, or listed combination high-low switch, interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure.
2. Pressure setting shall be adjusted by the installer in accordance with the burner or equipment manufacturer's instructions.
3. Pressure switches that require venting to the outside atmosphere shall be vented in accordance with 248 CMR 7.03(11)(c). Pressure switches only may be manifolded.

(e) Accessible IPS plugged pressure tappings or connections shall be provided; one located upstream of the main gas pressure regulator and another located near the

burner head to permit accurate measurement of gas pressure. (*See* 248 CMR 7.03 Figure 3.)

TABLE 2  
Minimum Pipe Size/CSST for Venting  
Gas Train Components in 248 CMR 7.04 Figures 3a, 3b, 3c, and 3d.

Gas Train Components	Maximum lengths of iron pipe or corrugated stainless steel tubing (CSST) from components to outside the building		
	0 - 40 feet	0 - 100 feet	0 - 200 Feet
Main Gas Pressure Regulator - Steel Pipe Size - CSST Size (Low Pressure Gas only)	¾ inch IPS 30/31 EHD	1 inch IPS 37 EHD	1¼ inch IPS 46/48 EHD
High & Low Gas Pressure Switches When Manifolder - Steel Pipe Size - CSST Size (Low Pressure Gas only)	¾ inch IPS 30/31 EHD	1 inch IPS 37 EHD	1½ inch IPS 60/62 EHD
Block and Bleed Valves (when used) - Steel Pipe Size - CSST Size (Low Pressure Gas only)	Full IPS Relief	Increase IPS/CSST one Size	Increase IPS/CSST two Sizes

(12) Operating Sequencing. (See also 248 CMR 7.04, Initial Start-Up and Final Adjustments). Each installation shall be equipped to provide for sequencing in accordance with the following and in the order listed.

- (a) Natural and mechanical draft systems with continuously burning pilot(s) capable of igniting any gas flowing from the main burner shall, upon demand for heat:
1. Prove all interlocks.
  2. Prove combustion air flow for mechanical draft systems.
  3. Prove in light-off position, if either an automatically operated damper, or an automatically operated air shutter, or both, are employed.
  4. Prove combustion (input) control, if employed, in light-off position.
  5. Prove pilot(s).
  6. Admit fuel to main burner.
  7. Prove main flame, if required, in accordance with 248 CMR 7.03(4)(e).
  8. Release combustion (input) control.
  9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
  10. Shut off fuel to main burner on release from demand.

- (b) Natural draft systems with intermittent pilot or interrupted pilot shall, upon demand for heat:
1. Prove all interlocks.
  2. Prove open for at least 90 seconds if either an automatically operated damper, an automatically operated air shutter, or both, are employed.
  3. Prove in the light-off position if either an automatically operated damper, and automatically operated air shutter, or both are employed.
  4. Prove combustion (input) control, if employed, in light-off position.
  5. Prove pilot(s).
  6. Admit fuel to main burner.
  7. Prove main flame, if required, in accordance with 248 CMR 7.03(4)(e).
  8. Release combustion (input) control.
  9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
  10. Shut off fuel on release from demand.
  11. If an automatically operated damper is employed, return to stand-by position.

- (c) Mechanical draft systems with intermittent pilot or interrupted pilot shall, on demand:

1. Prove all interlocks.
2. If an automatically operated damper is employed, prove in open position.
3. Start fan(s) and prove air flow. Provide at least a four-air change purge of the combustion chamber and equipment passes. The four air changes must be accomplished in not more than 90 seconds with burners having maximum firing rate per combustion chamber of not more than 2,500,000 Btu per hour. With burners having maximum firing rates per combustion chamber in excess of 2,500,000 Btu per hour, the four air changes shall be accomplished without time limitation by an air flow rate not less than 60% of the air flow provided for the maximum firing rate.
4. Prove combustion (input) control and automatically operated damper, if employed, in light-off position.
5. Prove pilot(s).

6. Admit fuel to main burner.
7. Prove main flame, if required, in accordance with 248 CMR 7.03(4)(e).
8. Release combustion (input) control.
9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
10. Shut off fuel on release from demand.
11. If an automatically operated damper is employed, return to stand-by position.

#### 7.04: Initial Start-up and Final Adjustments

(1) For gas equipment with an input of one million BTU's or more per combustion chamber, an authorized representative of the equipment or burner manufacturer shall perform the initial start-up, final adjusting and testing of the burner and controls in the presence of the gas inspector. Additionally, the serving gas supplier must be notified at least 48 hours in advance of the initial startup to be given the opportunity to attend the startup.

(2) Purging of gas equipment. The furnace, passes, and connected flue piping shall be thoroughly purged before lighting of pilots or burners. This shall be done by creating air flow through the setting by fully opening flue dampers and air shutters and by operation of induced and forced draft fans, if present.

(3) Control Operating Tests.

(a) All controls shall be thoroughly checked for proper operation and sequencing before the burner is put into operation. Manufacturer's instructions shall be followed.

(b) All safety shutoff gas valves shall be tested for gas tightness while in the closed position before being placed in service. During this test, gas shall be shut off to all burners downstream from the safety shutoff gas valve.

(4) Pilot Operation Tests.

(a) After the gas piping has been thoroughly cleared of air and any foreign materials, the pilot burner shall be lighted and adjusted with the main burner manual and automatic valves in the closed position. Adjustment to the pilot shall be made in accordance with manufacturer's instructions.

(b) Pilots shall not deposit carbon when adjusted according to the manufacturer's instructions.

- (c) When escapement or bleed pilots are used, the discharge shall be in a fixed position and shall be freely ignited by the continuous burning pilot or vented to a safe location.
- (5) Burner Operation Tests.
- (a) The main burner shall be put into operation and tested only after 248 CMR 7.04(2), (3), and (4) have been completed. Manufacturer's instructions shall be followed for light-off and adjustment of the main burner.
  - (b) Pilots shall reliably effect immediate ignition of the main burner even when the gas supply to the pilot(s) is reduced to a point where the pilot flame is just sufficient to actuate or energize the flame detection device. Follow the manufacturer's instructions in conducting this test.
  - (c) Continuously burning pilot flames shall not become extinguished: when the main burners are turned on or off in a normal manner, either manually or by automatic controls, when the air flow through the burner is rapidly changed from maximum to minimum or vice versa after the main burners are shut off following operation of the equipment at its maximum capacity, nor during any normal operating conditions that will occur. The above tests shall be repeated three times.
  - (d) The pilot burner shall reliably ignite the main burner under any normal condition of operation.
  - (e) The arrangement of burners, valves, and pilots shall be such that when only the pilots supervised by the flame safeguard equipment are in operation, any burner or combination of burners shall be effectively ignited without delayed ignition or flash back.
  - (f) Burner flames shall not flash back when fired at any rate within the installed operating range of the burner.
  - (g) Burner flames shall not flash outside the equipment when the gas is turned on or off by the automatic control mechanism.
  - (h) Proper air-gas ratio shall be maintained and combustion shall be complete over the full installed operating range of the burner.
- (6) Test for Venting. A check shall be made for proper venting with the burner operating at maximum installed input and with all building exhaust fans operating which are in communication with the room containing the equipment and with all outside closeable boiler room openings shut.
- (7) Instructions to the Operator.
- (a) Complete written or printed instructions including wiring diagrams shall be supplied and made conveniently available or posted in a permanent form in a prominent place near the equipment. These instructions shall include complete

start up as well as normal and emergency shutdown procedures. Start up shall be from the methods provided by the control system for that purpose.

- (b) To guard against malfunctioning all controls should periodically be tested on a scheduled basis.
- (c) Extended Shutdown. When equipment is shut down for an extended period it is recommended that in addition to closing all gas valves, as a further precaution, gas be prevented from leaking into the equipment by blocking off or disconnecting and capping or plugging the gas supply pipe.

#### REGULATORY AUTHORITY

248 CMR 7.00: M.G.L. c. 112, § 61; M.G.L. c. 142, §§ 13 and 21.