COMBUSTION CONTROLS

INTRODUCTION

Most heating equipment for building heat or for processing involves either gas or oil fired equipment. Without proper controls, unburnt fuel can get into the combustion chamber and cause an explosion or the piece of equipment could lose the cooling water and damage the unit. Depending on the type and size of the unit, different codes and standards would apply.

- Boilers with a fuel input rating below 12,500,000 Btu/hr (3.7 MW) should comply with ASME CSD-1 and this guideline, boilers 12,500,000 Btu/hr (3.7 MW) or greater, should conform to NFPA 85 and this guideline.
- Ovens for processing materials should conform to NFPA 86 and this guideline.

Some equipment such as space heaters and unit heaters are custom made and would not be listed by a testing laboratory. In that case refer to PRC.4.3.1.

POSITION

To insure proper operation of the equipment, controls are installed on the unit and the fuel line to shut the flow of fuel to the unit if a safety device activates. There are numerous safety devices ranging from high and low gas pressure switches, excessive steam temperature and pressure, low water, loss of combustion air and purge timers.

This guideline will cover the safety devices that require additional explanation or supplement the code or standard.

Equipment Location

Locate equipment such as gas meters, manual shutoff valves, safety shutoff valves, regulators, and controllers in an accessible location, not requiring ladders or special equipment to access them. Locate the equipment away from explosion panels, vehicle access routes, and other means of mechanical damage.

Do not install fuel fired equipment on a roof unless there has been a structural evaluation of the roof support system to make sure the roof system can handle the additional dead load. Do not install the fuel fired equipment within 50 ft (15.2 m) of a parapeted fire wall.

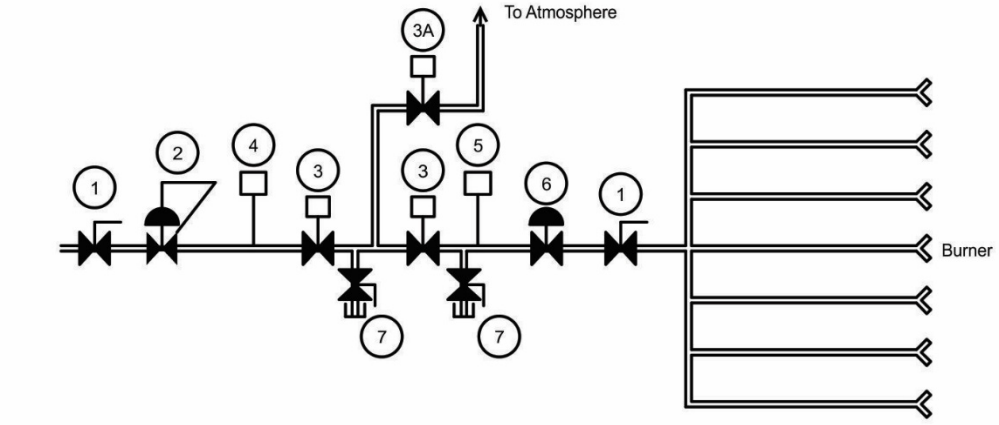
Fuel Gas Safety Shutoff Valves

Fuel gas safety shutoff valves stop the flow of gas to the combustion chamber when an unsafe condition has been detected. While the reliability of listed equipment has improved, there have been many time where the safety shutoff valve has to close tight, but couldn't.

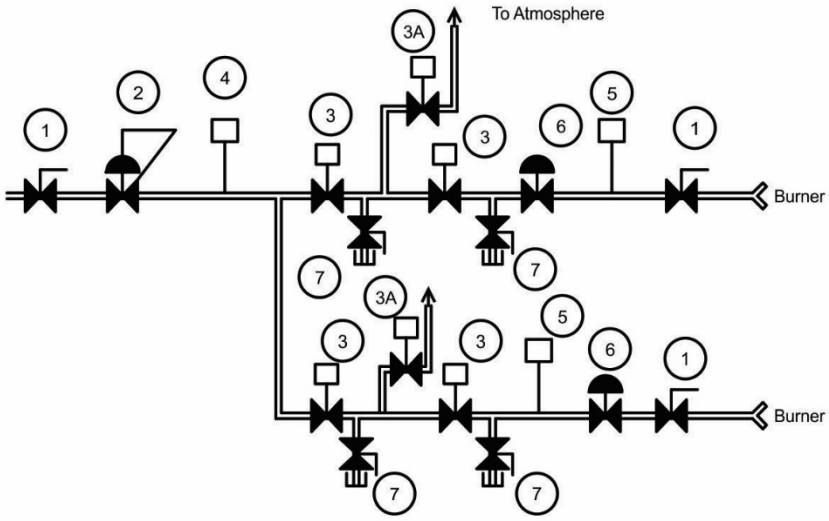
Locate the second safety shutoff valve as close to the burner as possible to reduce the amount of fuel in the burner line.

Vent Lines

Provide ovens with burners or burner systems operating at 400,000 Btu/h (117 kW) or above with a vent line connected between the two safety shutoff valves on both the main and pilot fuel gas burner systems (see Figure 1).



Multiple Burners On A Burner System



Single Burner On A Burner System

1. Manual Shut-off Valve
2. Regulator
3. Safety Shut-off Valves (normally closed)

3A. Vent Valve (normally open) Piped To Atmosphere

4. Low Gas Pressure Switch
5. High Gas Pressure Switch
6. Modulating Valve
7. Leak Test Valves

Figure 1. Fuel Gas Train.

Where the boiler code or standard requires a vent line between the two safety shutoff valves, or an oven operating at 400,000 Btu/h (117 kW) or above, install the vent line with a normally open vent valve in case a safety shutoff valve leaks. Route the vent line to an outside safe location, where the discharging gas cannot reenter the building or process equipment.

There are two types of vent systems, vents to atmosphere and atmospheric vents. The vent to atmosphere is the vent between two safety shutoff valves and vents from pressure relief valves. These vents would have gas in them when the safety shutoff valves close and the vent valve opens. The atmospheric vents are the vents from gas regulators, switches, and any other equipment requiring atmospheric pressure to balance a control diaphragm. These vents normally do not have any gas in the system.

Size the vent in accordance with Table 1. Limit the length of vent lines to a maximum of 50 ft (15 m). If longer runs are unavoidable, or an unusual number of fittings are necessary, increase the size of the vent line.

TABLE 1
Vent Line Diameters

Fuel Line Diameter	Vent Line Diameter
≤ 1½	¾
2	1
2½	1¼
3	1¼
3½	1½
4	2
4½	2
5	2
5½	2½
6	2½
6½	3
7	3
7½	3
8	3½

SI Units: 1 in. = 25.4 mm

Manifolding of vent line can be done. However vent lines from other equipment **CANNOT** be manifolded together. **DO NOT** manifold the atmospheric vent lines (those from gas regulators, switches, and any other equipment) with the vents to atmosphere (those between the two safety shut-off valves or pressure relief valves). The manifolded line has to be at least as large as the largest vent line plus 50% of the area of each additional vent.

For example, a multiple burner boiler has three 1 in. (1.36 in.^{2}) [25 mm (490 mm^2)] vent lines and a 1½ in. (2.9 in.^{2}) [38 mm (1134 mm^2)] vent line.

The manifolded line should be at least:
2.9 + (3 x (0.5 x 1.36)) = 4.94 in² or a 2½ in. diameter ((1134 + (3 x (0.5 x 490)) = 1869 mm² (50 mm) diameter) vent line.

An acceptable alternative to the vent line between the two safety shutoff valves is the valve proving system. There are numerous types of systems. One uses a small pump to pressurize the piping between the two safety shutoff valves. If the pressure is maintained, the startup or shutdown operations are allowed to continue. If pressure fails to be maintained in the piping, the system will lockout the startup operation and sounds an alarm until the leak is repaired. During shutdown operation, the pilot is brought back on line and the piping is pressurized. If the pressure is not maintained, the pilot stays on and an alarm is sounded. Another type of system has the down-stream safety shutoff valve close just prior to the up-stream safety shutoff valve, trapping gas between the two valves and the combustion air fan is running. The piping between the valves is then monitored and if pressure is not maintained, the down-stream valve is leaking. If the pressure is maintained, the down-stream valve is open momentarily to allow the gas to go into the combustion chamber where it is ignited by the pilot. The up-stream valves opens momentarily allowing gas into the piping between

the valves. The pressure is monitored and if the pressure increases the up-stream valve is leaking. Activate the system automatically upon startup and shutdown.

Proof Of Closure

The proof of closure indication should not be activated by the energizing or deenergizing to the actuator, but rather should be tied directly to the valve stem or valve clapper.

Flame Supervision – Ultra Violet Flame Scanners

Use only scanners that incorporate a safe start check feature. The safe start check feature verifies that the scanner is not reporting a flame signal before allowing the start sequence to begin.

For boilers and ovens with burners that continuously operate for more than 24 h, use only self-checking ultra-violet (UV) flame scanners. UV scanners can fail to an unsafe mode. When such failures occur, the UV scanner will report the presence of flame whether flame is or is not present. The use of self-checking detectors will shut the unit down when the fault is detected.

Explosion Relief

Arrange explosion relief panels for ovens so that when they operate, they do not damage critical equipment, utilities or building components.

Fuel Oil Fired Equipment

Provide automatic sprinkler protection at least over the firing end of the unit. The operating temperature of the sprinklers should be at least 50°F (27°C) higher than the maximum temperature at the ceiling.