The Basics of Combustion Safeguards

1. Flame Supervision may be defined as the detection of the presence or absence of flame. If a flame is present during the intended combustion period, the supervisory system will allow a fuel flow to feed combustion. If absence of flame is detected, the fuel valves are de-energized. This basic definition does not consider the start-up or ignition potential hazards.

   A dangerous combustible mixture within a furnace or oven consists of the accumulation of combustibles (gas) mixed with air in proportions that will result in rapid or uncontrolled combustion (an explosion). The magnitude of the explosion depends on the quantity of gas and the air-to-fuel ratio at the moment of ignition.

2. Sensors used for monitoring flames are either flame rods or ultra-violet (UV) scanners. Heat actuated sensors such as thermocouples and filled capillary bulbs may only be used on small burners (below 150,000 BTU/HR). Industrial burners must be protected by a safeguard which reacts to flame failure in a time interval not to exceed 4 seconds. Infrared detectors may be used, but they are sensitive to hot refractory, are temperature sensitive, are vibration sensitive, require special shielded or twisted pair wire, and should have wire runs kept under 50 feet. A flame rod essentially is a stainless steel wire that intersects the flame. When an electric potential is applied to a flame rod (in the case of a PROTECTOFIER, 390 volts), current flows from the rod to ground. Electrically, the flame is a diode and resistor in series. We call this the flame rectification principal. Flame rods are low cost and provide a steady reliable signal. Limitations are 600°F ambient temperature (when dielectric of the ceramic breaks down), 2200°F flame temperature (when s.s. rod begins to droop) and soot producing fuels such as oil. Ultra-Violet scanners can sense both gas or oil flames. They can also detect ignition spark, and are not immune to gamma rays, solar UV, welding sparks and some lighting products which may produce UV. They also must be protected from excessive ambient heat. A heat seal assembly with either plain quartz lens or magnifying quartz lens, a non-metallic fiber insulator, or purge air may have to be used. Flame signal strength for both types of sensor may be checked with an analog microamp test meter.

3. Sequence for flame safety starts with purging the furnace or oven. Purge time should allow four air changes. Fuel valves can and do leak gas. The purpose of purge is to remove combustible gases from the combustion chamber before introducing an ignition source. Four air changes in the combustion chamber are based on a worst case scenario of having a burner chamber completely filled with gas. Airflow for purge is verified, proof of valve closure may be verified, safety limits are proven, then the purge timer (which may or may not be integral to the combustion safeguard) determines the period of time required to evacuate the combustion chamber.

4. When purge is complete, the ignition cycle may be started. Some burners have to be in a "low fire" firing rate. The flame safeguard provides power to the pilot fuel valves (2 pilot valves are usually required) and the ignition transformer which in turn steps voltage up (usually to 6000 volts) to fire a spark plug or sparking electrode. The pilot must be established and proven within 15 seconds or the flame safeguard will de-energize the pilot valves and ignition source. If a pilot is not used, the main gas valves are energized from the pilot valve(s) terminal on the combustion safeguard. This is called a direct ignited burner.

The cause of failure to light-off must be determined, re-purge, and manual intervention (either reset or manual start) should occur before another ignition trial is attempted. If there is one purge timer for multiple burners with individual safeguards, re-purge may not be required.

The combustion safeguard always has a safe-start function to provide a component check on every cycle. It usually also provides a fixed non-adjustable purge timer and a fixed non-adjustable ignition trial timer.

5. After the pilot is ignited, the main valves are powered to allow fuel to the main burner, where the pilot flame provides ignition. Usually there are two main valves to provide a better protection against possible valve leakage. When the main valves are fully open, the pilot valve may be de-energized so that the flame sensor is only monitoring the main flame. Upon a loss of flame the combustion safeguard de-energizes the fuel valves in less than 4 seconds. While the main fuel valves are slow opening, they are fast closing. Pilot valves and main valves should have proof of closure if the applicable burner exceeds 400,000 BTU/HR.

6. If a furnace or oven has a multiple burner combustion system with only one valve train, a multi-burner PROTECTOFIER combustion safeguard would be used. If one burner fails, they all go out.

7. Typical safety limits that must be proven and maintained in a series electrical circuit with the combustion safeguard are low and high gas pressure switches, airflow, and high temperature. If any of these permissives fails, opening the circuit even for a fraction of a second, the fuel valves are de-energized. For this reason, a TELE-FAULT II First Outage Fault Finder annunciator is a valuable tool for system maintenance and trouble shooting.

8. Protection Controls, Inc. recommends checking the combustion safeguard and flame sensor weekly for continuous operation and monthly for daily operation. The best way to test is to simulate flame failure by closing an upstream gas cock. The fuel shut-off valves should snap shut within a few seconds.

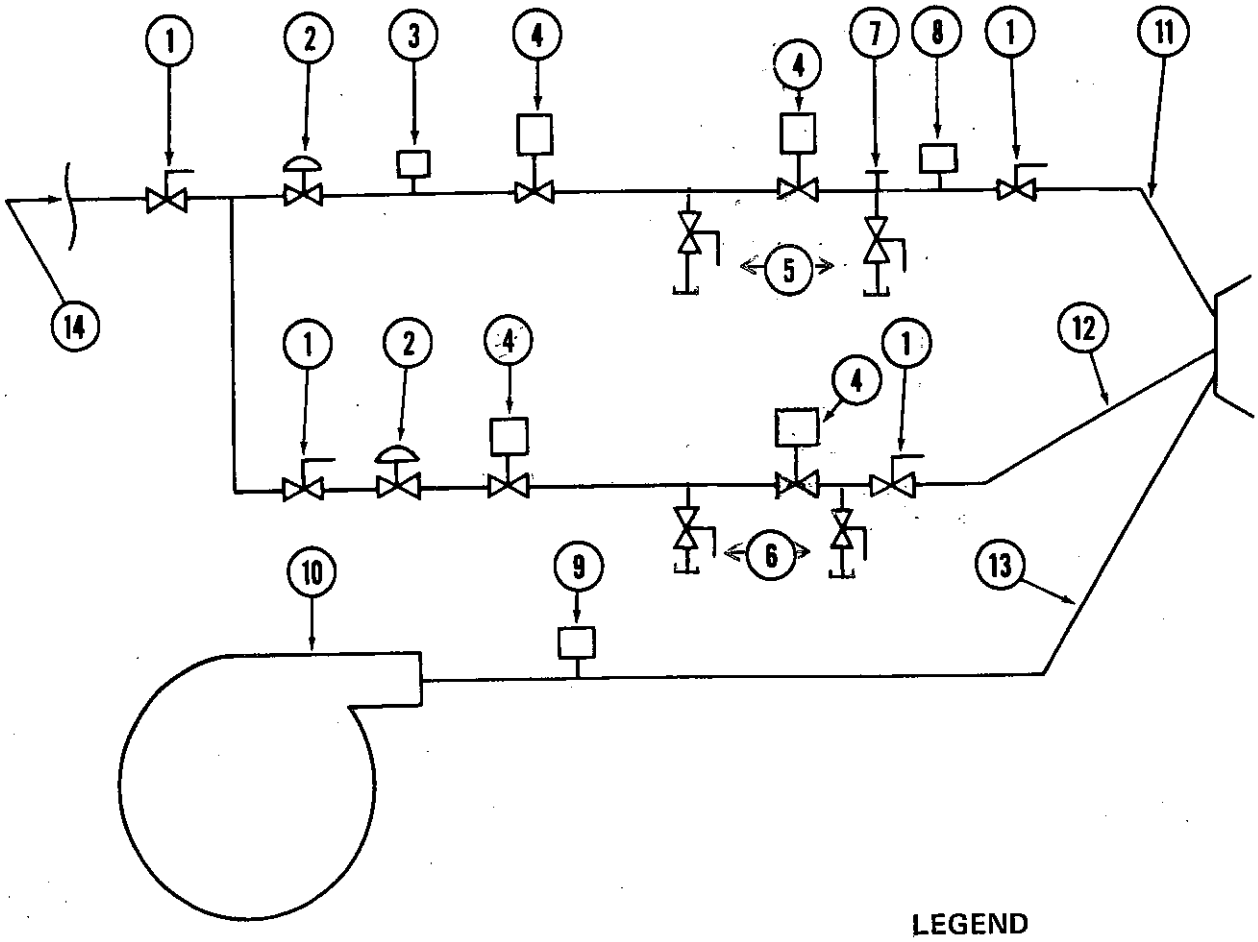
9. Fuel valve leak test should be performed once per year. Also, high gas pressure switch, low gas pressure switch, combustion air pressure switch, and high temperature limit switch should be tested once per year.

10. A furnace operating above 1400°F does not require combustion safeguards when above 1400°F, but it does at any time the temperature is below 1400°F.

11. For additional information, see PROTECTOFIER wiring diagrams, operating sequences, and the service manual. Also, see NFPA 86 standard on furnaces and ovens.

GAS-FIRED PIPING AND VALVE SCHEMATIC

TYPICAL ARRANGEMENT



LEGEND

1. Manual Cock
2. Pressure Regulator
3. Low Gas Pressure Switch
4. Safety Shut-Off Valve
5. Main [Leak test valves
6. Pilot [Leak test valves
7. Test Connection
8. High Gas Pressure Switch
9. Combustion Air Pressure Switch
10. Combustion Air Blower
11. Main Burner
12. Pilot
13. Combustion Air
14. Gas Supply

FIGURE 1

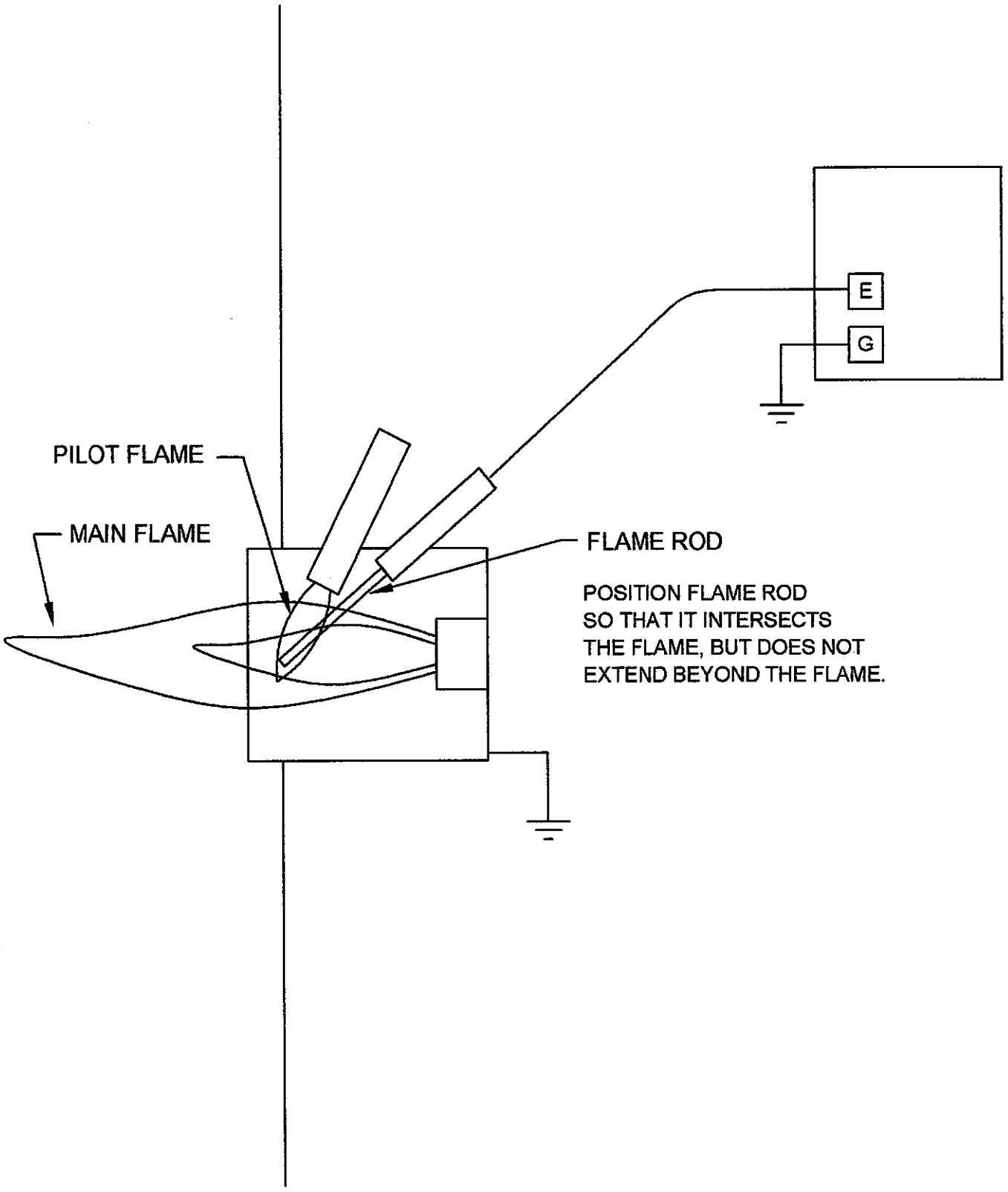
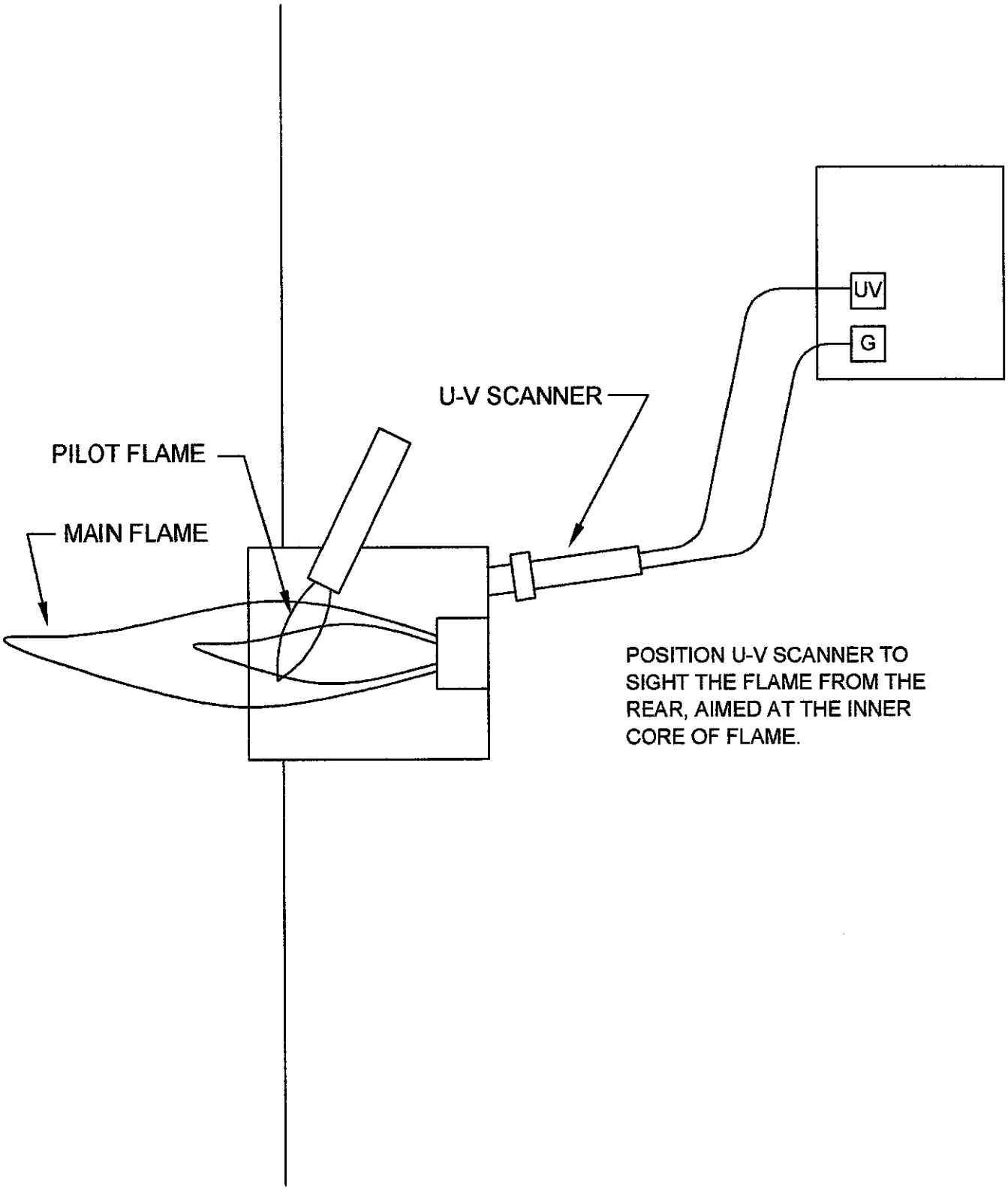

E
G
PILOT FLAME
MAIN FLAME
FLAME ROD
POSITION FLAME ROD
SO THAT IT INTERSECTS
THE FLAME, BUT DOES NOT
EXTEND BEYOND THE FLAME.

FIGURE 2


UV
G
U-V SCANNER
PILOT FLAME
MAIN FLAME
POSITION U-V SCANNER TO SIGHT THE FLAME FROM THE REAR, AIMED AT THE INNER CORE OF FLAME.