STAR ELEMENTARY SPENCER, OKLAHOMA

Hot water heater in school kills seven

What follows is an extract from the fire journal report on an incident that took place at the Star elementary school in 1982.

A malfunction of an 85-gallon hot water heater occurred during a lunch period at the Star Elementary School in Spencer, Oklahoma, on January 19, 1982. One corner of the cafeteria was destroyed by the explosion and pieces of concrete block were thrown across the lunchroom. Six children and one teacher were killed and 33 others suffered injuries of varying degrees. The malfunction was caused by overheating of the water in the tank and lack of emergency temperature-relieving capability.

Two gas-fired water heaters were located in a corner of the kitchen, in a small utility room. The two water heaters were piped in series; the first heater, Heater A, heated water to approximately 160°F for the kitchen, a lavatory in the northwest corner of the kitchen, and a sink on the kitchen side of the lavatory wall. The second heater, Heater B, was supplied from Heater A where the temperature of the water would be boosted to 1800-190°F for use in the rinse cycle of the dishwashing machine. It was the opinion of the investigative team that the burner on the high temperature heater (Heater B) had fired continuously from the time that the plumber completed his service on the tank, at approximately 11:00 am, until the explosion at 12:15 pm -a time span of about one hour and fifteen minutes.

The probable cause of the continuous firing of the burner was the failure of the thermostat, because internal corrosion within the thermostat had eroded a portion of the seating surface, allowing a small amount of bleed gas to pass through the damaged seat; hence, the leakage of the bleed gas through the thermostat sent a signal to the burner valve to remain in the open position. From information available, this thermostat control was estimated to be 12 to 14 years old.

Markings on screw heads and internal inspection indicated that the thermostat on Heater B had been opened in the field; comments by school maintenance personnel indicated that this was a common practice, the purpose being to recalibrate the thermostat to allow for higher temperature settings.

Testing and internal inspection revealed that the upper temperature limit control was inoperable before the explosion. The Fire officers report concluded that an attempt had been made to adjust the control; mis-alignment of the control spring indicated that the control had ceased to function, since the mechanism would not seal off the flow of bleed gas. This control was also estimated to be 12 to 14 years old.

The pressure and additional temperature-relief protection for the exploded tank was a combination pressure and temperature-relief valve (commonly called "T&P relief valve") in a common housing. After close examination, the investigators determined that the temperature-sensing element had been removed, leaving the T&P valve with no temperature-relief capability. They further discovered that the relief valve had been improperly installed, using a 45° elbow fitting which would have made it impossible to install the valve with the temperature-sensing element in place and properly projecting into the upper six inches of water in the heater.

The continuous build-up of heat from an uncontrolled burner with no emergency temperature-relief capability resulted in a water temperature above 212°F (i.e. superheated water). When the tank failed, a portion of the superheated water instantly expanded to steam, creating the thrust that propelled the tank pieces and the shock-wave effect identified as the blast, or explosion. Other factors that had some bearing on the accident, either directly or indirectly, were reported by the Fire officer:

- The investigation revealed that there was no preventive maintenance program in place or in practice.
- The supervision of maintenance engineers to determine the quality of their work and field practices was inadequate.
- The lack of in-service training for maintenance engineers permitted practices that were not in the best interests of safety and performance of the equipment.
- Warehousing of valves and controls at the Maintenance Center was done in a manner that increased the possibility of damage to the parts.

The accident demonstrates the need for a means to prevent temperatures above 212°F in water heaters, because a hazard does not exist if the liquid in a container is at a temperature below its normal boiling point. The missing temperature-relief element, set at 210°F, in the temperature-pressure relief valve would have been one such means. Without this, the high temperature thermostat in the control circuit for the automatic valve was the only such means in place. This was intended to close the valve when the temperature reached 210°F. However, it failed -apparently due to corrosion.