Coffee Break Training - Fire Protection Series

Fire Alarms & Detection: Rate Compensated Heat Detectors

No. FP-2012-29REV July 17, 2012

Learning Objective: *The student shall be able to explain the operating principle of spot-type rate compensated heat detectors.*

A rate-of-rise device is a common type of heat detector that responds when there is a rapid temperature increase in the space where it is located. In some cases, however, a spot-type rate-of-rise detector may not be suitable for the environment that needs to be protected. A rate compensated detector may offer an appropriate alternative.

This cutaway closeup of a rate compensated detector shows the position of the electrical contacts in the open circuit position.

A rate compensated detector operates when the ambient air temperature reaches a predetermined level, regardless of the rate at which it increases. The detector will operate at its design temperature during slow-building fire conditions or will respond promptly during rapid fire buildup.

A rate compensated detector relies on the physical property that metals expand when heated. Rate compensated detectors have typical temperature ratings between 135 °F and 220 °F (57 °C and 104 °C). These are spot-type detectors that have a sealed, external metallic tubular casing. Inside, there is a pair of electrical contacts that are attached to the sealed end of the tube. The alloys of the external tube and internal struts are different materials that heat and expand at different rates. Designed to resist thermal energy absorption and sealed inside the outer tube, the struts respond to temperature changes more slowly.

As the detector is heated:

- The outer casing expands lengthwise and pulls the contacts with it.
- When the internal contacts close, the alarm circuit is completed, and an alarm sounds.
- The detector is self-restoring when the temperature returns to normal.

The opposing forces (expansion and contraction) are balanced in such a way that on a slow rate of temperature rise, heat takes longer to penetrate to the inner element. This prevents the contacts from closing until the total device has been heated to its rated temperature.

When the air temperature is rising at a rate of about 40 °F (22 °C) per minute or less, the unit is designed to respond almost exactly at the point when the air temperature reaches the unit's design temperature. On a fast rate-of-rise, though, there is not as much time for the temperature to penetrate the inner element, so the expanding force of the outer shell closes the contacts more quickly. This minimizes thermal lag.

For additional information, refer to National Fire Protection Association (NFPA) 72, *National Fire Alarm and Signaling Code*.