Technical Bulletin

Detect-A-Fire® Rate Compensated Heat Detector Principles of Operation

The DETECT-A-FIRE® (D-A-F) detectors are the "heart" of many fire protection systems. The highly reliable D-A-F has been the standard for over 75 years. The D-A-F is used for signaling overheat or fire conditions. In the vast majority of applications, the D-A-F provides the initial heat sensing that is used to activate suppression systems using clean agent, CO2, inert gases, wet or dry chemicals or water.
The E2S hazardous area H1 range of heat detectors emloy D-A-F elements with stainless steel enclosures and hermetically sealed contacts. Certified with the E2S explosion proof and increased safety junction boxes, approvals include IECEx, ATEX, UL, cUL. Versions include Class I/II Div 1, Ex db explosion proof and flame proof as well as Class I/II Div 2, Ex db eb increased safety and Zone 0 Ex ia intrinsically safe models.

Preface

Traditionally there are two types of heat detectors: fixed temperature and rate-of-rise. There may be circumstances where neither of these methods is optimal and another method is needed. The rate-compensated heat detector element used in the E2S range of H1 type heat detectors has unique characteristics.

D-A-F detectors are widely accepted, because they are designed with rate compensation. This provides a unique advantage over both fixed temperature and rate-of-rise types of detectors because the D-A-F detector accurately senses the surrounding air temperature regardless of the fire growth rate. At the pre-determined set point, the system is activated This document explains the principles of the Detect-A-Fire ® (D-A-F) rate compensated heat detector.

E2S range of heat detectors

- **D1xH1**: www.e2s.com/1-27-010
- **GNExH1**: www.e2s.com/1-27-020
- **STExH1**: www.e2s.com/1-27-030
- **D2xH1**: www.e2s.com/1-27-040

Fixed Temperature

Fixed temperature devices activate when the entire detector unit is completely heated to the operating temperature. Under fast rate fire conditions and sudden temperature rise, there could be a lag in response time before some types of fixed temperature detectors have fully heated and activate.

Rate-of-Rise

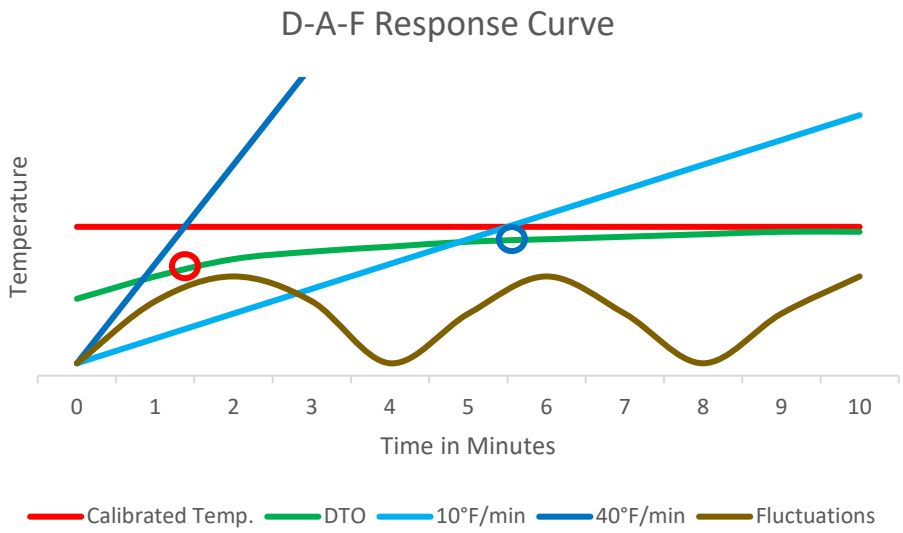
Rate-of-Rise devices activate when ambient temperature increases at a predetermined rate (typically 15°F per minute). False alarms can happen when there is a sudden rush of heated air such as the rush of warm air from process ovens when doors open. These types of devices may also fail to activate if there is steady but slow rise in heat below the 15°F per minute rate, such as in a smoldering fire.

Combination Fixed & Rate-of-Rise

A combination of both technologies can also be unreliable. An example of this would be if you had a temperature increase of 10°F per minute. This would be slow enough to not trigger the rate of rise activation and still be fast enough to cause a lag in activation.

Rate Compensated

Rate compensated devices such as the D-A-F act as a fixed temperature device that compensates for both ambient temperature changes and fast rate-of-rise situations. This design allows the detector to “anticipate” fire conditions and thus activate before the fixed temperature is reached in a fast fire. The functionality of the detector is generally not affected by transient temperature changes when being installed in typical outdoors environments where the temperature can vary from extreme cold to warm and will reliably activate at it’s designed fixed temperature.



D-A-F Response

In the above graph, the red line represents the calibrated temperature of the D-A-F. The dark blue line is a temperature rise of 40°F/min while the light blue line is a rise of 10°F/min, most typical fires fall within this range. The green line represents the device temperature at operation (DTO) which you can see is lower than the calibrated temperature as part of the rate compensated design. The faster the rate of rise, the lower the temperature the D-A-F activates.

In reviewing the above data, you can see that in a rate of rise condition of 40°F/min, that the D-A-F is activating approximately 10% below the calibrated activation temperature (noted by the red circle). The D-A-F activates in anticipation of the activation temperature because the surrounding air heats faster than the internal strut assembly of the D-A-F.

Additionally, in reviewing figure 2, you can see that in a rate of rise condition of 10°F/min, that the D-A-F is still activating below the calibrated activation temperature (noted by the blue circle). The D-A-F is still anticipating the activation temperature but by a smaller percentage because the internal strut assembly of the DAF more closely matches the air temperature.

The brown line in figure 2 represents fluctuations in air temperature that can be caused by exposure to the sun or heat from an oven door being opened. A typical rate of rise detector may activate due to the sudden change of temperature, but the D-A-F will not activate if the temperature is safely below the calibrated activation temperature. The manufacturer recommends the activation temperature to be 100°F above the normal maximum ambient temperature.

Calibration, Verification, and Testing

At the factory, calibration of the D-A-F starts by placing the uncalibrated units into a temperature controlled heat block and preheating them at the calibration set temperature for 45 minutes. The system then performs an initial setting to the calibration temperature. The units are then "burned-off" by sending a 10A current at 24VAC through the electrical contacts for 6 cycles of open and close of the circuit, this cleans the electrical contacts inside the D-A-F. The units are then calibrated to the set temperature of the heat block and allowed to cool off to room temperature.

Verification of the D-A-F calibration is completed in a separate automated test system that utilizes a single station aluminum heat block for each unit. The power to the heater internal to the heat block is controlled by the switch contacts of the unit itself and monitored electronically though the automated test system. The power to the heater is set dependent on the unit's set temperature in order to achieve the ideal "50% on - 50% off duty cycle". This means that the block's heat and cool cycle is measured to be the same time with the unit heating up and cooling down at roughly the same time interval. This process is repeated 10 times to stabilize the product and then another 5 times for the official verification of calibration. The final 5 actuation temperatures are then recorded and the average of the 5 readings is then compared to the set temperature and required tolerance. If the unit is outside the required tolerance, the D-A-F is rejected. The final 5 actuation temperatures are also compared from cycle to cycle for repeatability. If the cycle temp varies by more than 3 degrees from one cycle to the next cycle, the D-A-F is rejected.

Note: It is important to know that heat transfer varies by medium and using air or oil will provide different results then the aluminum block used at our factory.

Since it is difficult to test in a manner similar to the factory, we recommend when testing to always ensure that you are heating slower than the 1°F per minute or your results will be affected by the anticipation factor of the D-A-F.