# **Updating flame detection and releasing systems:** What industrial plants that make or use energetic materials need to know

**Energetic materials are defined as those with a high amount of stored chemical energy that can be released. Materials classes included are explosives, pyrotechnic compositions and propellants. For manufacturers that handle these materials, time is critical for dealing with events that may endanger personnel and property. Process control setups in these facilities must include systems that respond in milliseconds when certain materials catch fire, because of their potentially rapid burn rate and the damage that may result should the materials ignite.**

**This article, by Mike Hosch of Det-Tronics, looks at the components of ultra-high-speed flame detection and releasing systems and explains why plant managers and safety engineers should consider upgrading to the latest versions of these systems.**

In hazardous manufacturing settings, ultra-high-speed fire systems are designed to detect a flame in its incipient stage and then quickly apply large volumes of water to extinguish or help to control the spread of the fire. Facilities that require these systems are those that use, process and/or manufacture "energetic" materials such as explosives, gunpowder, propellants and pyrotechnic compositions.


Figure 1 – Because there is little international code guidance available for the ultra-high-speed industry, US codes can be applied to these systems

Not surprisingly, a major user of energetic materials is the munitions industry. Machines that process energetic substances often involve large amounts, while the processes – filling shell casings or pressing materials into forms – can cause a rapid deflagration of the materials that requires an immediate response.

Similarly, the materials used to activate automotive airbags may be present in significant quantities near airbag manufacturing machines. If these energetic materials catch fire, damage can result to the process machinery within the plant.

Energetic materials are also a danger in plants that fill aerosol spray cans. To make spraying possible, a propellant is added to the mixture inside the can. If a can isn't sealed properly during the manufacturing process, a cloud of propellant can form in the air near production machinery – which can possibly ignite and start a large flash fire. In a case like this, it's important to stop the machine as quickly as possible so more propellant isn't released into the environment causing the situation to propagate.

Energetic material manufacturing environments aren't the only places where ultra-high-speed fire detection can help avert disaster. Consider high-voltage direct current (HVDC) electric power transmission stations, which house large transformers and switch gear. If a fire breaks out at an HVDC station, it's imperative to shut down the equipment as quickly as possible so that large amounts of voltage and current are stopped as quickly as possible to prevent further damage to the equipment. For this reason, ultra-high-speed fire systems may be connected to the shutoff equipment in these stations.

Another possible application for ultra-high-speed fire systems is in automated vehicle paint booths. As a vehicle moves through a paint booth, a spark from static electricity produced by paint moving through the spray nozzle may direct fire at the vehicle along with paint. The applicable standard in this case requires that flame detectors respond to such a fire within 500 milliseconds. Connecting the flame detector to an initiating device circuit of an ultra-high-speed fire system can help reduce the potential damage to the facility by increasing the speed with which the system can respond.

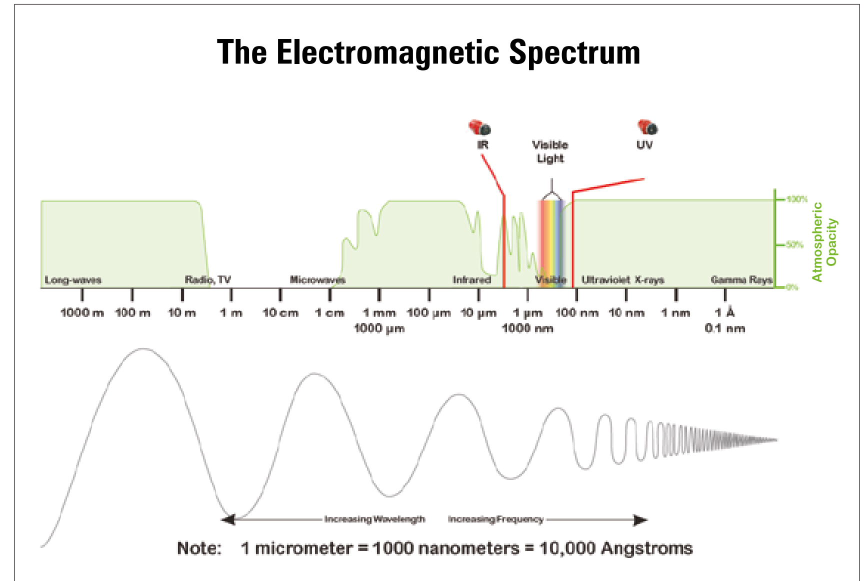


Figure 2 – A broad view of the electromagnetic spectrum depicting the infrared (IR) and ultraviolet (UV) regions that are favourable for the detection of flame

## Applicable codes and standards

There is little international code guidance available for the ultra-high-speed industry. In the United States, codes that address requirements for ultra-high-speed flame detection and releasing systems include:

- Unified Facilities Criteria: UFC 3-600-01, *Fire Protection Engineering for Facilities.* This code applies to facilities that are owned by the United States federal government.
- National Fire Protection Association: NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and NFPA 72, *National Fire Alarm and Signaling Code.*

NFPA 15:2017 Chapter 12 states that an ultra-high-speed flame detection and releasing system must respond in no more than 100 milliseconds (a tenth of a second) from the presentation of an energy source at the detector to the flow of water from the deluge nozzle.

The codes and standards also require fire alarm systems to be "listed" by a Nationally Recognised Testing Laboratory (NRTL). For instance, UFC-3-600, 9-18.12 requires panels used for fire suppression system control or release to be listed by a NRTL. Another example is NFPA 72: 2016, 23.11, which requires releasing devices for suppression systems to be listed for use with releasing service alarm.

Besides being designed for reliable performance at a critical time, fire-protection equipment listed by an NRTL has been approved by a third party. Properly accredited third-party testing and certification provides potential users with an independent and unbiased product evaluation. A number of independent organisations test fire protection equipment using documented safety and performance criteria.

Over the last 30 years, codes and standards related to fire protection in industrial settings have evolved and are now more stringent. These codes and standards cover important topics such as the supervising of system inputs and outputs (I/O). In addition, system requirements such as those for protection from electromagnetic and radiofrequency interference (EMI/RFI) are more stringent.

In countries where no specific codes and standards for ultra-high-speed fire systems exist, the aforementioned US standards can provide guidance on good engineering practices and what constitutes an effective fire-protection system. Facilities that have determined that an ultra-high-speed fire system may be beneficial within the application may find that US codes and standards for ultra-high-speed fire systems can help to provide guidance for system design attributes.

## A look at the systems

Typical components of ultra-high-speed fire systems include flame detectors, a central control system, a solenoid, a pilot-operated valve, a pre-primed deluge piping system with nozzles, and a water supply.

Optical flame detectors are used to detect a fire from a given material of interest. These devices sense and analyse the electromagnetic radiation emitted by a flame. When burning, different types of materials emit differing spectra of light energy that allow their detection. The region of spectral emission to which a detector is sensitive, must be tightly controlled in order to minimise the effects of spectral emission from non-fire sources such as sunlight, ambient light, machinery and processing equipment.

Optical flame detectors employ several sensing technologies, including ultraviolet (UV), infrared (IR), ultraviolet / infrared (UV/IR) and multi-spectrum infrared (MIR). MIR technology, however, cannot respond quickly enough for ultra-high-speed applications. When selecting from among the remaining options, potential users must match the spectral response of the detector to the spectral emissions of the fires to be detected.

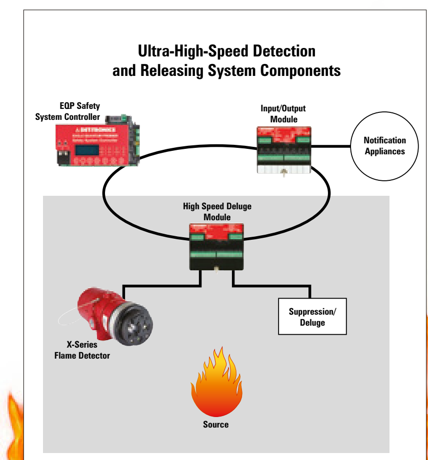


Figure 4 - An example of today's ultra-high-speed flame detection and releasing systems

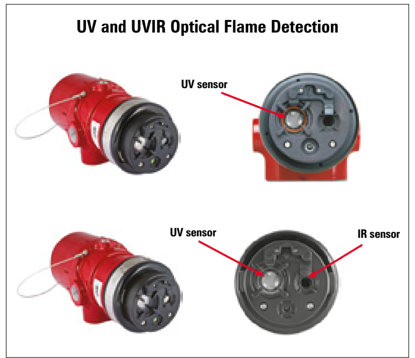


Figure 3a – Both UV and UVIR optical detection technologies are capable of detecting flames rapidly enough for use in ultra-high-speed applications

Ideally, an optical flame detector should be performance-tested with the fire type of interest to determine its effective detection range. Flame performance testing can also determine a detector's coverage area, or field of view (FOV). In ultra-high-speed applications, detectors are installed as close as possible to the area that requires monitoring, typically at distances of less than three metres. Optical flame detectors require a clear line of sight to the area being monitored, so they must be installed in locations with no obstructions between the detector and the area of interest.

Under ideal circumstances, ultra-high-speed flame detectors can detect a rapidly developing fire in approximately 30 milliseconds. The response speed of the detector, however, is only a small subset of the response time of the entire system. The speed of response of the entire system is the most critical metric. Other system components that must be taken into account include the releasing service fire alarm control unit, which may also respond in a matter of milliseconds. In addition, the solenoid takes time to relieve the pilot pressure from the deluge valve. Lastly, water requires time to travel out of the nozzle.

To optimise the speed of response:

- Detectors designed to detect the spectral emission of the material of interest should be considered
- Detectors should be installed as close as possible to the potential hazard
- All air should be purged from within the piping of the hydraulic system
- The fastest possible solenoids should be used
- Deluge nozzles should be installed as close as possible to the potential hazard

Those who take these steps may achieve optimal performance at the outbreak of fire, meeting or exceeding response time requirements.

## Why an upgrade makes sense

While older ultra-high-speed fire systems currently in use by munitions and other manufacturers may respond quickly enough to comply with codes and standards, these older systems may present challenges in terms of product support. In some cases, the manufacturers of older systems may no longer offer service support and replacement parts may not be readily available. When a component of the safety system fails, this could lead to a 'line down' situation until the issue can be resolved. In high-demand applications, waiting to replace the safety system until it no longer functions may lead downtime.

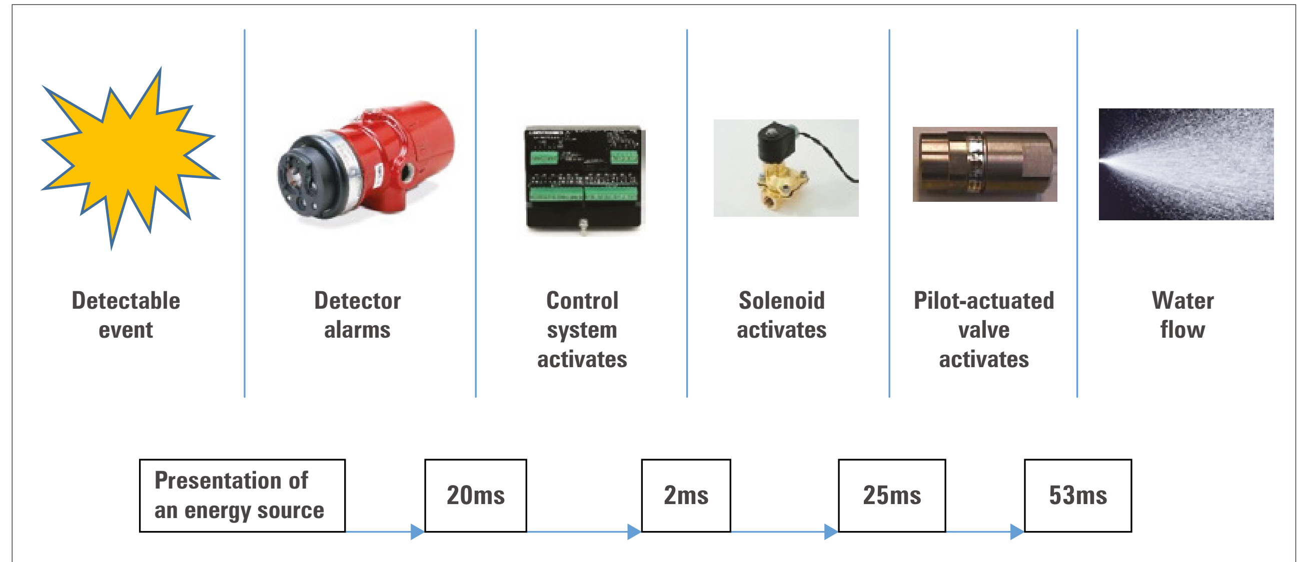


Figure 3b – Per NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, response time for an entire ultra-high-speed detection and suppression system from presentation of an energy source at the detector to flow of water from the water spray nozzle cannot exceed 100 milliseconds (ms).

Besides being up to date in terms of codes and standards, today's new systems offer more features, such as EMI/RFI protection and I/O monitoring. The latest systems are designed to be much more user-friendly than their older counterparts. Those systems typically communicate via LEDs and numerical displays, requiring plant personnel to be well versed in interpreting what they mean. New systems typically display easily understandable event information through text on the controller screen.

The latest ultra-high-speed fire systems are designed to retain more information about a hazardous event than older systems. New systems include a log that records and stores critical information such as the date, time and duration of an event, as well as which detectors were activated during the event. These systems can also transmit event data to a computer to facilitate review and analysis by plant personnel.

Another key feature of the latest systems is their ability to integrate with a facility's existing life-safety system. If a high-hazard event occurs, new systems can output information about the event to a connected life-safety system, which then carries out the appropriate alarm and notification functions in the building.

Whether working as a stand-alone system or in conjunction with life-safety systems, new ultra-high-speed flame detection and releasing systems upgrades are an important consideration for any process that requires a split-second response to hazardous situations. ■

About the author

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