DET-TRONICS

WHITE PAPER

Smoke detection in hazardous areas:

What you need to know

Smoke detection in hazardous areas requires detectors that operate effectively and safely in explosive environments. Having the correct equipment can mitigate the risk for facilities and workers in these demanding locations.

Smoke detection is the most common form of residential and commercial fire protection used today. There are also industrial applications that utilize smoke detection — due to code requirements and functional safety best practices — but many of these installations are in "hazardous locations." The detectors used in these settings are different from ordinary smoke detectors because electrical equipment used in hazardous areas must be rated for the risks associated with explosive substances.

The locations where hazardous-area smoke detectors are installed vary as well, from wall- and ceiling-hung detectors to those specially designed for duct-mounting in applications such as wastewater treatment and offshore oil platforms.

This document will describe some of the applications that require hazardous-location smoke detection, the design approaches for electrical equipment suitable for hazardous locations, and the codes and standards that guide the selection and installation of hazardous-area smoke detectors.

What is a hazardous location?

Chapter 5 of the National Electrical Code® (NEC), National Fire Protection Association (NFPA 70®) addresses "special occupancies." Within that chapter, Article 500 "Hazardous (Classified) Locations, Classes I, II and III, Divisions 1 and 2" stipulates that locations be classified based on the flammables that could be present, and their concentration or quantity. Hazardous-area classifications specific to electrical equipment are:

- **Class I:** areas in which flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures
- **Division 1:** a location where combustible materials are routinely present in ignitable concentrations
- **Division 2:** a location where the same materials are handled, processed or used, but in which the materials are normally confined and can escape only in case of accident or breakdown or failure of ventilation equipment

Within Class I, locations are also defined by Zones (0, 1 or 2) per Article 505 of NFPA 70. For example, in a Class I, Zone 0 location, ignitable concentrations of flammable gases or vapors are present continuously or for long periods of time.

What makes hazardous-area detectors different?

Electrical equipment installed in Class I, Division 1 and Class I, Zone 1 hazardous locations must be of a type designed to prevent the ignition of a flammable atmosphere, propagation of fire, or creation of an explosion. Equipment used in areas where explosive concentrations of vapors may exist must be equipped with special wiring and other electrical components for safety purposes. Hazardous (classified) locations such as these might exist in aircraft hangars, gasoline stations or paint-finishing locations.

NFPA 70 Section 500.7 "Protection Techniques" lists several techniques for protecting electrical and electronic equipment used in hazardous (classified) locations. The three acceptable protection methods for Class I Division 1 are *Intrinsically Safe (IS)*, *Purged and Pressurized* and *Explosion-proof (XP)*.

IS-designed equipment is designed with special circuitry that maintains the available energy to a value below that required to cause ignition — even under fault conditions. Most portable or battery-powered devices utilize the IS approach to achieve their hazardous area ratings.

With purged and pressurized devices, combustible gases and vapors are denied entry into the enclosure.

XP refers to devices that have housings designed and constructed so sparks or explosions are contained within the housing, preventing these from becoming an ignition source for gas within the hazardous area. The XP approach is commonly used for fixed installations where it is not practical to limit the power to field devices within the hazardous area.

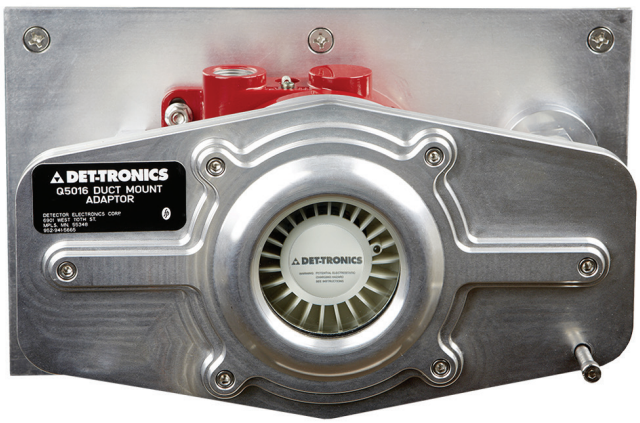
How do smoke detectors work?

A smoke detector detects the particles produced by combustion using a variety of technologies. These can include ionization, cloud chamber, photoelectric light obscuration, photoelectric light scattering and video image detection. To be effective, smoke detectors should be located and spaced in anticipation of airflow from sources likely to present fire risks (without resulting in unwarranted alarms). NFPA 72 describes the requirement this way:

> *17.7.1.9 The location of smoke detectors shall be based on an evaluation of potential ambient sources of smoke, moisture, dust, or fumes, and electrical or mechanical influences, to minimize nuisance alarms.*

Smoke detectors used in hazardous locations can be designed either for detecting smoke in defined areas or within ductwork. As with other types of detectors used in high-risk locations, it is critical that smoke detectors have the necessary performance and hazardous location approvals to operate effectively and safely in the application.

When specifying a smoke detector for hazardous areas, look for products with Class 1 Division 1 and IP44 ingress protection certifications, such as the Det-Tronics SmokeWatch™ U5015 Explosion-Proof Smoke Detector shown below. For duct-monitoring applications, the Det-Tronics duct mount accessory makes installation easy.



HAZARDOUS LOCATION APPLICATIONS

There are many industrial applications with hazardous locations that may require smoke detection for worker and facility protection, including:

Wastewater treatment facilities

- Duct detection for smoke control in HVAC systems
- Area detection in sludge processing and storage buildings, incinerator buildings, and underground tunnels

Volatile chemical storage

- Duct detection for smoke control in HVAC systems
- Area detection used in storage spaces

Munitions facilities

- Area detection in locations where flammable substances are being stored

Chemical processing plants

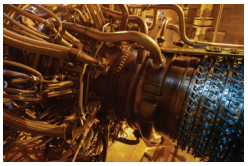
- Area detection in locations where flammable substances are being stored or used in manufacturing processes

Petroleum refineries

- Area detection in control house buildings and electrical substations
- Smoke detection in the sub-floor space, if the building has a sub-floor containing power cables

Offshore petroleum production and exploration

- Duct detection in HVAC systems supplying air to occupied work spaces



Turbine enclosures

- Area detection
- Duct detection in the enclosure exhaust

Battery rooms

- Area detection for electrical or smoldering fires

Pharmaceutical operations

- Duct detection used in the HVAC system
- Area detection in locations where flammable chemicals are stored or are used in manufacturing processes

OEM painting operations

- Area detection in paint and chemical storage spaces

Shipyards

- Area detection in volatile chemical storage spaces

Aircraft hangars

- Area and/or duct detection in paint and corrosion control storage spaces

For general fire safety codes plus industry-specific standards and guidance regarding hazardous-area smoke detection, see the next page.

What are the safety standards for smoke detectors?

Before embarking on the design of a life safety smoke detection system, plant engineers should review applicable safety standards, which can provide the backbone of a plan to help ensure continuous safe operation of plant processes. Fire protection requirements are legislated and subject to a myriad of international codes and standards that address which devices and systems should be included in a life safety plan. There are also standards that deal with detector performance, installation, calibration and maintenance, all of which are critical to effective smoke detection.

The following are codes and standards commonly utilized by companies needing hazardous area smoke detection.

GENERAL

NFPA 72 — National Fire Alarm and Signaling Code

- Standard for installation of fire control systems including smoke detection

NFPA 90A — Standard for the Installation of Air-Conditioning and Ventilating Systems

- Provides guidance for how and where smoke detectors are to be installed in HVAC applications

NFPA 92 — Standard for Smoke Control Systems

- Standard for the design, installation, acceptance testing, operation and periodic testing of smoke control systems

2012 IMC — International Mechanical Code

- Provides guidelines for the installation and use of smoke detectors in ventilation and exhaust systems

WASTEWATER

NFPA 820 — Standard for Fire Protection in Wastewater Treatment and Collection Facilities

- Provides specific guidance for how and where smoke detectors are to be installed in wastewater treatment facilities
- "Systems supplying or exhausting air at a rate greater than 2000 cu ft/min (56.6 cu m/min) shall include listed smoke dampers, listed fire dampers, and smoke detection and shall cause the ventilation system to shut down upon detection of smoke"

PHARMACEUTICAL

FM Data Sheet 7-36 — Pharmaceutical Operations

- 2.1.1.5, D – "Design all HVAC systems to minimize the transfer of contaminants or products of combustion from one area to another. Zone the HVAC systems to minimize cross-contamination, and install automatic smoke detectors in the return ducts interlocked with fire dampers."
- Smoke detection may be required in cooler and freezer raw material storage units. Reference 2.1.4.1 & 2.1.5.1
- Potential hazardous zones include areas in which volatile ignitable liquid is being used or stored

OIL & GAS OFFSHORE

API Recommended Practice 14C — Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety System for Offshore Production Platforms

- Recommends automatic fire detection in areas that are classified and in all buildings where personnel sleep
- Smoke detection is a viable fire detection method in enclosed areas

DNV-OS-D301 — Offshore Standard: Fire Protection

- Guidance provided on recommended fire detection technologies for different areas of the vessel
- Guidance provided on spacing of smoke detectors
- Obscuration should be between 2% and 12.5% per meter
- **Section 1** — Passive Fire Protection
  - "B 310: The ventilation of the accommodation spaces and control stations should be arranged in such a way as to prevent the ingress of flammable, toxic or noxious gases or smoke from surrounding areas. (MODU Code 9.2.20)"
- **Section 7** — Supplementary Requirements for Oil and Gas Production and Storage units
  - "F 103 — Automatic shutdown of ventilation is to take place upon:
    - Detection of fire in enclosed spaces, unless this is in conflict with overall smoke control strategy.
    - Smoke detection in ventilation air inlets."

How do I know which detectors comply with safety standards?

The most sure way to know that smoke detectors meet the safety standards that apply to your installation is to specify equipment with certification documentation. Codes such as NFPA 72 set out the performance levels to which each life safety device should be tested. Performance testing and certification verifies that a device will operate as specified by the manufacturer under worst-case standardized conditions.

Some smoke detector manufacturers self-certify product performance, meaning that they rely solely on their own internal tests and evaluation to attest that their products meet applicable standards. Other manufacturers add a testing report from third-party organizations which may not have proper laboratory accreditation. Though safety-device manufacturers know their devices and are knowledgeable in their field, properly accredited third-party testing and certification provides an independent and unbiased evaluation of the design and product performance.

Accredited third-party testing is done by experts in reliability engineering and certification process. A number of independent organizations have documented safety and performance criteria for smoke detectors. These include FM Approvals and Underwriters Laboratories (UL) in the U.S., the Canadian Standards Association (CSA) in Canada, Det Norske Veritas — Germanischer Lloyd (DNV GL) in Norway/Germany and UL-DEMKO in Denmark. When these organizations certify a product, it means that independent experts have determined that it is fit for duty.

Conclusion

Whether your facility is processing or storing flammable chemicals, smoke detection is most likely both a code requirement and a functional safety best practice.

Providing fire detection solutions can be a complex task in high-hazard applications because there are specific standards to address. Where a risk of explosion is present, equipment must be specifically designed for use in explosive atmospheres. Having the correct equipment can mitigate the risk for facilities and personnel in these demanding locations.

Disclaimer

The content of this white paper is provided for informational purposes only and is not intended to provide professional services or substitute for the review and advice, in any given circumstances, of an appropriate professional. Det-Tronics makes every effort to provide timely and accurate information but makes no claims, promises, or warranty regarding the accuracy, completeness, timeliness, or adequacy of the information provided in this paper, and expressly disclaims any implied warranties and any liability for use of this white paper or reliance on views expressed in it.

About Det-Tronics

Det-Tronics is a global leader in fire and gas safety systems, providing premium flame and gas detection and hazard mitigation systems for high-risk processes and industrial operations. The company designs, builds, tests and commissions SIL 2 Capable flame and gas safety products ranging from conventional panels to fault-tolerant, addressable systems that are globally certified. Det-Tronics is a part of Carrier, a leading global provider of innovative HVAC, refrigeration, fire, security and building automation technologies.

74-1015-1.1

DET-TRONICS

Corporate Office
6901 West 110th Street
Minneapolis, MN 55438 USA
det-tronics.com

Phone: +1 952.941.5665
Toll-free: +1 800.765.3473
Fax: +1 952.829.8750
det-tronics@carrier.com

Carrier