

FIRETRACE
AUTOMATIC FIRE SUPPRESSION SYSTEMS

Fire Protection for Cable Tunnels

Targeted protection

November 2009

Details on fires in cable tunnels and how to suppress them using **FIRETRACE**® automatic suppression systems

Background Information

A fire in an underground tunnel can be a devastating event. With limited access and difficult working conditions, fire and smoke can rapidly become a deadly enemy against your equipment and personnel working within the tunnel environment.



Traditional tunnel fire protection systems require regular fire barriers, complex detection and control systems and typically tons of water, or other extinguishing agent, to protect against a fire. The cost of refilling the system after a discharge, let alone the initial installation, can be extremely expensive.

Cables are often the main source of fire situations in confined spaces, such as tunnels. Often tightly packed together and in large quantities, they can generate a lot of heat which can cause the cable to burn at any point along its length, which makes detection and extinguishment of a cable fire particularly tricky.

In addition to the tunnel itself, there typically a whole host of other “microenvironment” fire safety challenges. These range from emergency lighting installations to essential-power cabling installations, generators, batteries and UPS equipment, control cabinets, sub-stations and fuel stores

FIRETRACE® can offer a targeted solution to deal with the fire at its source



FIRETRACE® detection tubing can be laid out over large distances

Systems require no external power to operate, and very little maintenance

System only activates in the event of a fire, no false alarms

FIRETRACE® systems can be fitted in a matter of hours

Easy to retrofit old cabinets and new builds

Pressure gauges allow for quick and easy checks on the system to make sure they are always operational



FIRETRACE® can be fitted with a pressure switch to signal that a fire has occurred

Quick acting so only minimal damage is done to equipment

System can be quickly replaced after a fire has taken place



Why use Firetrace?

Choosing the right system for use underground is extremely important.

Safety is of paramount importance when working underground and it would be pointless to extinguish a fire in a tunnel, only for an engineer to investigate later on and be affected by the discharged agent.

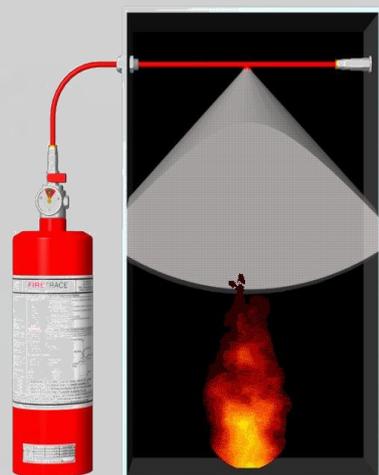
Similarly, the agent must be clean, so as not to cause any damage to expensive equipment and cables following a discharge.

Not only that, but you need assurance that your systems have been supplied and installed by a quality organization, with third party testing and accreditation on the design and application of each system type.

Firetrace Systems, chosen to protect long cable runs are of the Direct Low-Pressure (DLP) type and use 3M™ Novec™ 1230 as the extinguishing agent.

In the event of a fire, or high temperature rise, the Firetrace Detection Tube (FDT) will burst and discharge the extinguishing agent directly on to the fire at its source, rapidly knocking down any fire. The agent quickly fills the area, cools the surrounding area and, by incorporating a pressure-switch to operate at discharge, power can be shut down to avoid re-ignition.

Being non-toxic and safe for people at normal extinguishing concentrations, Novec 1230 is ideal for use in confined, occupied spaces and is also perfect for use on electrical fires and those involving normal combustible materials.



Direct System Example

The system is also fitted with a pressure switch that constantly monitors the contents of the container and can be used to shut down power and integrate with your existing SCADA system, in the event of a system discharge following a fire. This will enable you to pinpoint exactly where the fire occurred, as only the system that actuated will be required to operate, rather than trying to total-flood a whole section of tunnel.

Firetrace Detection Tubing is ideal for fire detection in tunnel and cable trays as it tolerates any dust, dirt, moisture and temperature extremes of these environments. Also, being pneumatically operated, the system requires no power to operate and does not place additional strain on the electrical system.

Following a discharge, the activated system can be quickly restored to operation, by replacing only the section of FDT that has ruptured. Provided spare, ready filled containers are available on site, a new container can be fitted to the system and the tube re-pressurized in only a few minutes, ensuring minimal downtime and disruption for any of your client's operations.

What other system choices are able to provide such flexibility?

FIRETRACE® Detection Tubing (FDT)

At the heart of all **FIRETRACE®** systems is the Firetrace Detection Tubing, or FDT. This flexible, pneumatic tubing is the primary fire detection and unit activation method used in all **FIRETRACE®** Automatic Suppression Systems. It is flexible enough to be used in the most difficult installations, yet durable enough to withstand harsh conditions and continue to perform as intended.



Firetrace Detection Tubing

The FDT is a linear, pneumatic, fire detection device that responds to a combination of heat and radiant energy generated by a fire. When exposed to these conditions, the properties of the FDT in this localized area change. The material becomes softer and weaker than the surrounding areas. In this weakened state, the gas contained inside of the FDT is able to burst through, releasing the pressure in the entire length of FDT. This rupture and depressurization of the FDT is what activates the rest of the system, which discharges the fire suppression agent.



FDT after Detection

The FM Approved Firetrace Detection Tubing (FDT) is a linear, pneumatic, fire detection device that responds to a combination of the heat and radiant energy from a fire. The FDT is non-porous, so it can contain internal pressure for an extended time. The FDT is also resilient to most common chemicals or substances. The FDT is made of an inert, non-conductive blend of proprietary resins, and then extruded using a special process to ensure that the tubing is non-porous. This unique blend of materials gives the FDT the following attributes:

- Excellent Physical Durability and Flexibility
- High Pressure Performance
- Wide Temperature Range
- Good Chemical Resistance*
- Excellent UV Resistance

*Tests on chemical resistivity performed by Oxford University

System Specifications

Novec 1230 Fire protection fluid

The extinguishing agent used in **FIRETRACE®** pre-engineered automatic indirect fire suppression units is Dodecafluoro-2-methylpentan-3-one, more commonly known as Novec 1230.

Novec 1230 (1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE) is a colourless low odour fluid, low in toxicity, electrically non-conductive, leaves no residue, and is an extremely effective fire suppression agent. Novec 1230 is included in NFPA-2001, under the generic name FK-5-1-12, and has been evaluated and approved for use in occupied areas as a Total Flooding agent; when used as specified under the U.S. Environmental Protection Agency (EPA) SNAP Program rules.

Refer to the SNAP Program rules for more information.



Cleanliness

Novec 1230 is clean and leaves no residue, thereby minimizing after fire clean up along with keeping expensive downtime to a minimum. Most materials such as steel, aluminium, stainless steel, brass, as well as plastics, rubber and electronic components are not affected by exposure to Novec 1230. This agent is also environmentally friendly, having ozone depletion potential (ODP) of 0.00 and an atmospheric lifetime of 5 days (the closest halocarbon alternative is 33 years). (3M, 2003)

3M™ Novec™ 1230 Fire Protection Fluid Environmental Properties Comparison

| Properties | Novec 1230 | Halon 1211 | Halon 1301 | HFC-125 | HFC-227ea | HFC-23 |
|--|------------|------------|------------|---------|-----------|--------|
| Ozone Depletion Potential (ODP) ¹ | 0.0 | 5.1 | 12.0 | 0.0 | 0.0 | 0.0 |
| Global Warming Potential-IPCC ² | 1 | 1300 | 6900 | 3400 | 3500 | 12000 |
| Atmospheric Lifetime (years) | 0.014 | 11 | 65 | 29 | 33 | 260 |
| SNAP (Yes/No) | Yes | N/A | N/A | Yes | Yes | Yes |

¹ World Meteorological Organization (WMO) 1998, Model-Derived Method

² Intergovernmental Panel on Climate Change (IPCC) 2001 Method, 100 Year ITT

Not for specification purposes
All data other than those for Novec 1230 fluid were compiled from published sources

HFC-227ea Extinguishing Agent

An alternative extinguishing agent used in **FIRETRACE**[®] pre-engineered automatic direct fire suppression units for electrical enclosures is Heptafluoropropane, more commonly known as HFC-227ea, or FM200. HFC-227ea (1,1,1,2,3,3,3-heptafluoropropane, $\text{CF}_3\text{CHFCF}_3$) is a colourless odourless gas, low in toxicity, electrically non-conductive, leaves no residue, and is an extremely effective fire suppression agent.

HFC227ea has been the standard clean agent for many years and is well know and trusted worldwide

HFC-227ea is included in NFPA-2001 and has been evaluated and approved for use in occupied areas as a Total Flooding agent.

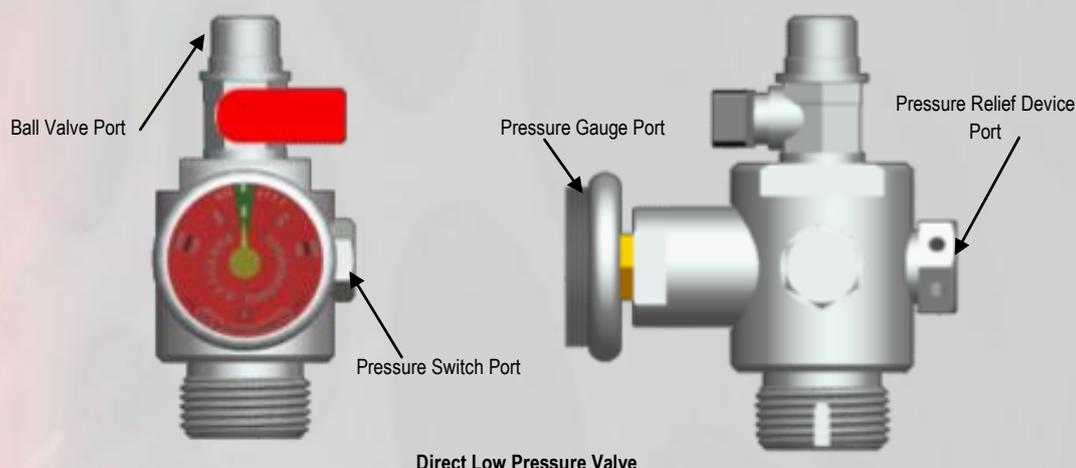
HFC-227ea is clean and leaves no residue, thereby minimizing after fire clean up along with keeping expensive downtime to a minimum. Most materials such as steel, aluminium, stainless steel, brass, as well as plastics, rubber, and electronic components are not affected by exposure to HFC-227ea. This agent is also environmentally friendly, having an ozone depletion potential (ODP) of 0.00.

For hazard information, decomposition information, and physical properties of FM200 please refer to the Material Safety Data sheet located in the System Manual, or contact Firetrace International Ltd.

Valve Assembly

Each cylinder is equipped with a nickel plated brass valve, a pressure gauge to monitor cylinder pressure, and a quarter turn ball valve that interfaces with the Firetrace detector tubing. The ball valve must be kept closed at all times when the cylinder is not in service.

In addition, all DOT cylinder valves are equipped with a pressure relief (rupture disc) device in compliance with safety requirements



(CE Manufactured Systems for the European market do not require a pressure relief device)

Pressure switch

A pressure switch is provided to monitor system pressure, system actuation and/or to energize or de-energize electrically operated equipment. This unit can be connected at the end of the line of the **FIRETRACE**[®] detector tubing, or on the container valve assembly to provide additional electrical functions as may be required. **FIRETRACE**[®] recommends that all systems use a pressure switch coupled with some device to alert personnel in the event of a system discharge

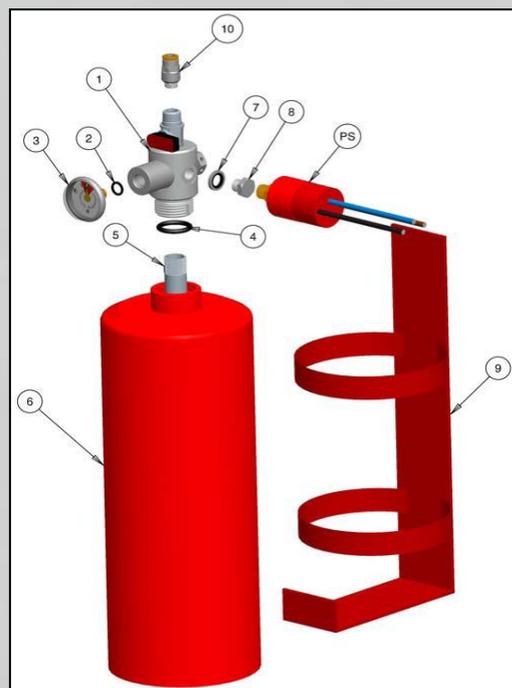
Cylinder/Valve Assembly

The extinguishing agent is stored in steel or aluminium cylinders super-pressurized with nitrogen to 150 psig at 70°F, for FM200 (10.3 bar at 21°C) or to 195 psig at 70°F for 3M™ Novec™ 1230 (13.4 bar at 21°C). Each cylinder is equipped with a straight siphon tube and can only be mounted in a vertical (upright) position.

A wall mounted painted steel bracket is used to mount the cylinder/valve assembly in a vertical (upright) position. Each bracket is equipped with two (2) integral quick-clamp straps

ITEM DESCRIPTION

- 1 DLP Valve
- 2 O-Ring, Pressure Switch/Pressure Gauge
- 3 System Gauge
- 4 Collar O-ring DLP
- 5 Siphon Tube
- 6 Low Pressure Cylinder
- 7 Bonded seal (pressure switch on valve)
- 8 Plug, pressure switch port on valve
- 9 Low Pressure System Bracket
- 10 HP Slip-on union



FIRE ALARM INTEGRATION

The Firetrace system is delivered including a factory installed normally open / normally closed Low Pressure Switch. This allows the discharge of a Firetrace system to be monitored and integrated with the Fire Alarm or Building Management system.

This output signal can perform other functions as required i.e. sounding alarms, shutting down equipment, activating dampers, fire doors etc.



The Firetrace systems do not need to be connected to an external power supply source so even in the event of a general power failure the Firetrace System is always on and ready to protect critical equipment against the risk of fire.

System Design

The Firetrace series of Pre-Engineered Automatic Direct Units' design limits were established and tested by Firetrace. The Pre-Engineered Automatic System concept minimizes the amount of engineering required when evaluating a design for a specific application. So long as the detection/discharge tubing is installed within the limits prescribed by Firetrace installation manuals, no calculations are required for pressure drop, flow rates, or discharge time.

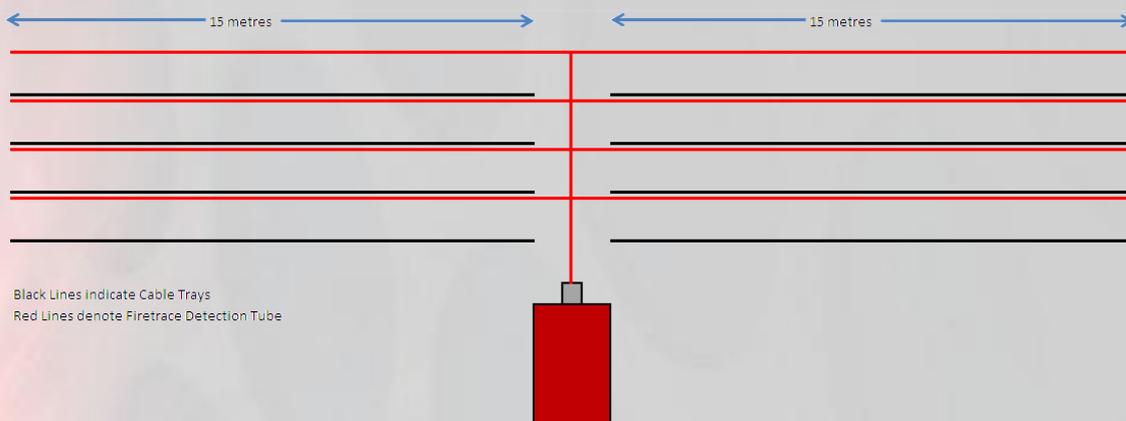
When the additional limitations of hazard volume, area coverage, maximum height, design concentration, agent quantity, detection arrangement, etc., are also met, the system installation can be understood to comply with the applicable design requirements, of the associated NFPA Standard. Therefore, no discharge tests or concentration measurements should be required.

For the purposes of the cable runs installed in the Cable Tunnel, Firetrace proposes that several, independent 5lb Novec 1230 DLP systems are installed along the total length of the tunnel, at regular intervals.

The testing that Firetrace has completed, in line with system design approvals, enables each Firetrace system to utilize 15m of FDT per run, in each direction away from the container assembly, meaning that we would require a cylinder to effectively be placed every 30m apart. Each of these could systems could protect multiple cable runs, but we would envisage that each side of the tunnel would require separate protection.

(A basic layout example is shown below)

It should be noted that we are concerned with the protection of cable trays and bundles and not random trails of cable along floors. These would need to be tidied and fixed in a position suitable for the Firetrace systems to be appropriately mounted.





If the cables are spaced well apart from each other, then we would recommend that the Firetrace Detection Tube is installed just above each cable run, supported in some way so that actuation is prompt in the event of a fire and the discharge is not unduly affected by the cables themselves. We would recommend some supporting device, such as a muncen ring or fixed metal bar that the tube could be attached to at regular intervals.

FIRETRACE® *Detection Tube Testing*

Leakage rate:

The FDT passed the Underwriters Laboratories and Factory Mutual Research long term leakage tests. Twelve sample systems, each with 52 feet of FDT were weighed and then placed in a secure storage area. The maximum allowable leakage rate was 0.0075 ounces leakage over a period of one year. Each quarter of a year, 4 random samples were selected and weighed. At the end of the full year, all twelve samples were weighed. There was no measurable leakage. The FDT passed the test.



Exposure to UV radiation:

Samples of FDT, each 12 inches in length, were subjected to the UV Light and Water Test in accordance with ASTM 154 utilizing the UVB 313 Lamp. Test duration was 1000 hours. Following this test, the samples were examined for cracking or deterioration. None was found. These same samples were then subjected to a hydrostatic test of six times the normal operating pressure ($150 \times 6 = 900$ psi) of the tubing for a period of one minute. There was no burst or leakage as a result of this test. Pressure was then raised to 1000 psi for a period of one minute with no burst. Each sample was then raised to burst pressure. Average burst pressure of the twelve samples was 1200 psi.

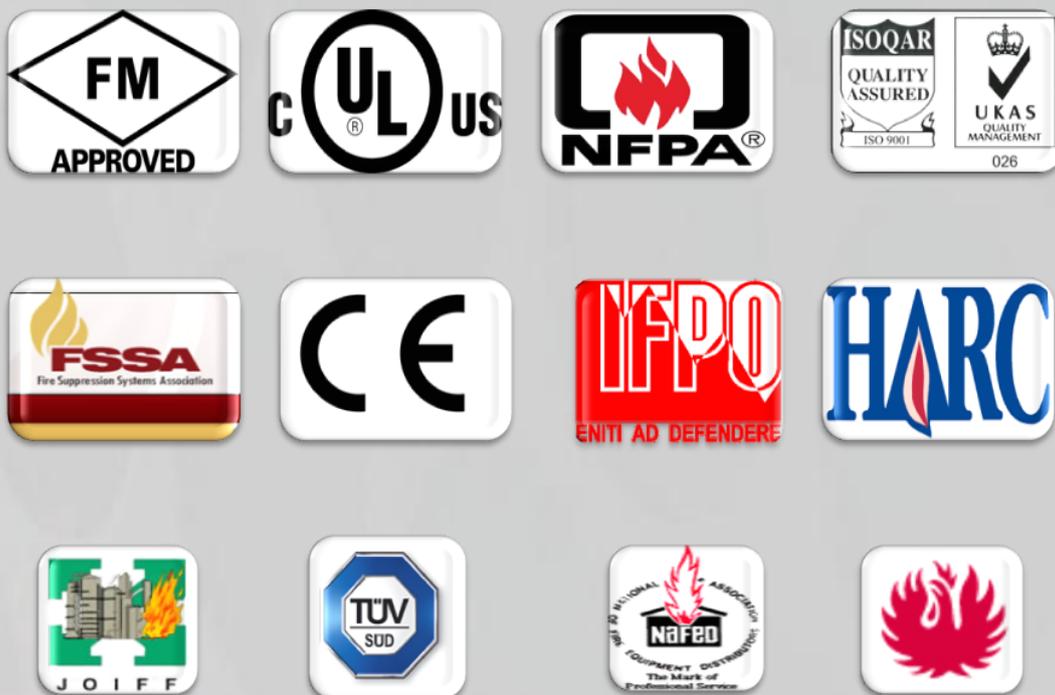
Aging Test:

A total of twelve samples of FDT, each twelve inches in length, were subjected to an air-oven aging test for 180 days at 212°F (100°C). Following this test, the samples were examined for cracking or deterioration. None was found. These same samples were then subjected to a hydrostatic test of six times the normal operating pressure ($150 \times 6 = 900$ psi) of the tubing for a period of one minute. There was no burst or leakage as a result of this test. Pressure was then raised to 1000 psi for a period of one minute with no burst. Each sample was then raised to burst pressure. Average burst pressure of the twelve samples was 1200 psi.

30 Day Extreme Temperature Leakage Test:

A total of twelve fully charged **FIRETRACE®** Indirect systems, charged with FM-200™ Clean Extinguishing Agent and super pressurized with nitrogen to 150 psi and including 24 inches of detection tubing (also charged to 150 psi) were exposed to the temperature extremes, 0°C (32°F) to 54.44°C (130°F), for a period of 30 days. A total of six charged systems were exposed to 0°F and six charged systems were exposed to 130°F. Weight (in grams) was recorded before and after the test. There was no loss of weight noted of any of the samples at the end of the test. Following this test the systems were discharged with a standard propane torch impinging on the FDT. System actuation was within two seconds and in each case, discharged as intended.

Approvals & Listings



FIRETRACE® International's systems carry several internationally recognised approvals and listings and have been independently tested by third parties for exposure to many types of chemicals, solvents and UV radiation. As an **ISO 9001** accredited company you can be sure of the fact that all systems are manufactured and tested in a quality environment.

Australia – SSL Listing No. AFP 1368 Scientific Services Laboratory, Victoria, Australia

Austria – Prüfstelle für Brandschutztechnik

Bahrain – State of Bahrain Ministry of the Interior, Protection and Prevention Section

Belgium – ANPI/NVBB Rapport D'essai no. SPT/ME 020/1987.12.08

China – CNAACL No. China National Accreditation of Laboratories

Czech Rep – Strojirensky Zkusebni Ustav S.P Engineering Test Institute

Denmark – Danish Institute of Fire Technology

France – CNPP GC01 0017 CNPP IE 99 5585

Germany – BAM/TUEV Approval

Greece – Approval Report 44672 701.6

Hungary – Belugyminiszterium Tuezoltosag Orszagos Parancnokszag Szum 188/31/1999

Israel – The Standards Institution of Israel Test Certificate 8013107171

Italy – TESI No. 094/B Tecnologie Sviluppo Industriale

Netherlands – TNO Netherlands Project Ref 006.10329.01.02

Romania – SC Instal Somet SA Act de Omologare No. 7/2000

Qatar – Civil Defence

Sweden – SBF 128:1 Swedish Bus Approval

United States - Factory Mutual Approval / UL & ULC Listing

Frequently Asked Questions

What pressure is the system working to?

The **FIRETRACE**[®] systems are super pressurized with Nitrogen to a pressure of 195psi, around 13.4bar.

What happens if I have more than one fire simultaneously?

Because the system is design is based on the volume of the enclosure, there is sufficient agent within the container to “total flood” the whole space. Should there be more than one fire, the Fire Detection Tube will burst at the hottest point first and all of the agent will be dispersed from that point. The whole area however, will rapidly fill with a cloud of dry chemical agent which will quickly suppress any other fires that there may be.

How can the operator check if the system is available and functioning?

A Firetrace system is fitted with two monitoring devices. A pressure gauge for visual inspection and also as described above the systems can be fitted with a set of low pressure switches which change state on 5bar falling pressure and can create “a fault” signal on a fire control panel. (Control panels normally supplied by 3rd parties but Firetrace can supply these also).

If the system is activated, do I need to replace the whole system?

No. Should you have the unfortunate incident of a fire, the system will operate as intended and some works will obviously need to be carried out to bring the system back into operation again. This involves re-charging the contents of the container via an approved agent, or for speed purposes, replacing the container with an identical one that is already filled. The Fire Detection Tube will not normally need to be replaced, as the burst point can be cut from the tube and the tube can then be re-connected with a straight adapter. The system can then be pressurized and reset for use.

In theory, your system could be operational again within only a few minutes and at minimal cost.

I've heard about HF, will this cause damage to my equipment?

The agents themselves are described as “Clean Agents” as they will not damage any equipment, or leave any residue, should they come into contact with any electrical components. However, they decompose at high temperatures and it is therefore important to avoid applications involving hazards where continuously hot surfaces are involved. Upon exposure to flame these agents will breakdown to form halogen acids. Their presence will be readily detected by a sharp, pungent odour long before maximum hazardous exposure levels are reached.

It has been concluded from fire toxicity studies that decomposition products from the fire itself especially carbon monoxide, smoke, oxygen depletion and heat may create a greater hazard.