ACTIVE FIRE PROTECTION GUIDE
OVERARCHING DOCUMENT

This document has been produced by the RISCAuthority Active Suppression & Detection working group to provide information and outline guidance on the application of watermist.

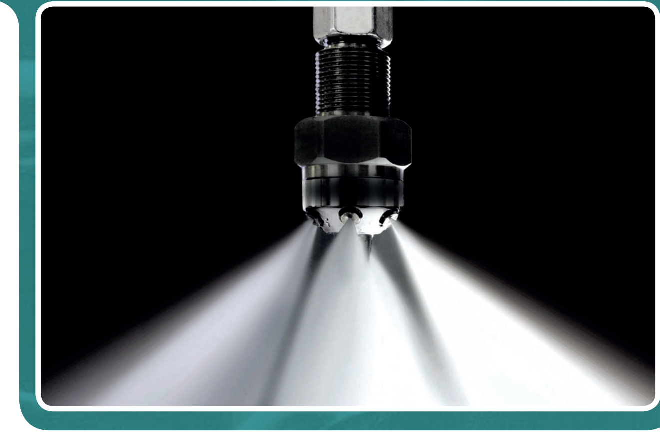
Contents

Introduction

This document is part of a series of Active Fire Protection Guides (AFPGs) produced by the RISCAuthority Suppression & Detection Working Group to provide summary information on the main types of fire suppression and extinguishing technologies currently available.

Choosing the most appropriate technology for any given situation requires the specifier to understand many important factors, such as the risk that needs protecting, the requirement of the system to either suppress or extinguish a fire, and the advantages/disadvantages and limitations of each technology type.

Incorrect choices, and even poor implementation of the correct technology, can lead to poor outcomes, significant fire losses, and potentially even death from exposure to the agent itself, its breakdown products in fire, or from the unreconciled fire event. This document and the associated guides are not intended to give definitive advice on system selection but should be considered as a primer, presenting key 'need-to-know information' for each of the main firefighting technologies, and act as a starting point in collating the relevant information needed to make a good choice of system.



Protected asset consideration

A major design consideration for any Active Fire Protection System (AFPS) is to establish the full scope of what needs protecting. The three principle categories are:

- building
- compartment
- item or equipment (Local Application).

Building protection systems

Building protection AFPSs have rulesets that describe the protection requirements for all areas of a building, including the habitable spaces, storage locations, car parks, bathrooms, voids, service ducts, etc. Deviation from any aspect of the rules can result in the system not being certificated. With requirements to ensure the passive building requirements support the robust operation of the system, these systems represent the pinnacle of resilient AFPS design for property protection and overall business resilience. The only systems that classify as Building Protection Systems are Sprinkler Systems to the LPC Rules, N.F.P.A and F.M. Global.

Compartment protection systems

Compartment protection AFPSs have rulesets that describe the requirement for the space they seek to protect only. Systems for compartment protection can include gaseous, watermist, domestic sprinkler, local sprinkler, water drencher, aerosol, and hypoxic systems. Comparison of protection proposals for **building protection** by sprinkler systems and watermist systems must be reviewed with extreme caution. Native to the sprinkler design will be an assurance of the coherent protection of all spaces, including i.e. hidden voids etc. as described above – the same will not be true for the watermist solution unless specifically and additionally designed to do so.

Item/equipment protection (Local Application)

Often termed 'Local Application Systems', these technologies are designed to respond quickly during any fire event to limit the scope area of damage to a specific piece of equipment, to prevent spread to other equipment, compartments, or the rest of the building. They are the first automatic line of defence in an 'onion-layer' approach to fire protection – effective local control can negate the need for a compartment or building protection system to operate, which can dramatically reduce consequential damage. All agent technologies can be applied as local application systems but there is a need to ensure that there is a good understanding of whether they are 'suppression' or 'extinguishing' systems as this will greatly impact the fire protection strategy (see next section).

Local Application Systems (including supporting control systems) generally must extinguish the fire and nullify all potential reignition sources within the timeframe of agent discharge.

Suppression versus extinguishment

Firefighting systems for buildings, compartments, or equipment typically fall into one of two categories – Fire Suppression Systems and Fire Extinguishing Systems – and it is important to understand the distinction between these. Traditionally, water-based systems have been used for suppressing fires, and gaseous-based systems for extinguishing fires. However, some technologies, such as watermist may be used to suppress fires for 'life safety' or extinguish fires for 'property protection'. Critically, in different countries, and even within some standards, the terms 'Suppression System' is sometimes used interchangeably with 'Extinguishing System' which is technically incorrect, causes great confusion, and at worst could lead the system owner to believe it will achieve more than it can in supporting the overall fire safety/resilience strategy. This confused terminology is also unhelpful in post-fire litigation.

Suppression system

These systems act by reducing the size or intensity of a fire and limiting its potential for further growth or spread. Whilst it is not a requirement of such systems to fully extinguish a fire, this may be achieved, but should never be depended on. These systems will be designed to operate for a specified minimum period of time only – normally the duration of agent supply (i.e. water tank size), or evacuation time for life-safety systems. The overall fire safety plan will require other actions, such as fire service intervention, to complete the job of fully extinguishing the fire prior to the suppression system's agent supply being exhausted. A fire plan that has dependencies on suppression systems but fails to specifically address the additional actions necessary to bring about full extinguishment is dangerously deficient.

Examples of suppression systems:

- Sprinkler systems
  - LPC Rules for Automatic Sprinkler Installations 2015 incorporating BS EN 12845 (Commercial & Industrial)
  - BS EN 12845:2015+A1:2019 Firefighting systems – Automatic sprinkler systems - Design, installation, and maintenance (Commercial & Industrial)
  - BS 9251:2021 Fire sprinkler systems for domestic and residential occupancies. Code of practice
  - BS EN 16925:2018 Fixed firefighting systems. Automatic residential sprinkler systems. Design, installation, and maintenance
  - N.F.P.A 13 – Standard for the installation of sprinkler systems
  - F.M. Global – Data Sheet 2-0 – Installation Guidelines for Automatic Sprinklers
- Watermist systems
  - BS 8489-1:2016 Fixed fire protection systems – industrial and commercial watermist systems. Code of practice for design and installation
  - BS 8458:2015 Fixed fire protection systems – residential and domestic watermist systems – code of practice for design and installation
  - BS EN 14972-1:2020 Fixed firefighting systems. Water mist systems. Design, installation, inspection, and maintenance

Extinguishing system

These systems act by bringing the combustion process of a fire to an end and removing any possibility of re-ignition. Typically, fire extinguishing systems contain a certain fixed amount of firefighting media that is delivered over a relatively short period. Consequently, if the system fails to fully extinguish a fire prior to exhausting its supply of extinguishant then the fire may rekindle and continue to burn unopposed. For this reason, these system types will need to be carefully considered, designed, and installed to ensure that the purpose of the system and the fire strategy can be realised. Extinguishment Systems require a high degree of control of the compartment in which they are operating.

Examples of extinguishing systems:

- Foam systems
  - BS EN 13565-2:2009 Fixed firefighting systems – Foam systems Part 2: Design, construction, and maintenance
  - N.F.P.A 11 – Standard for Low, Medium, and High-Expansion Foam
  - N.F.P.A 16 – Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
  - F.M. Global – Data Sheet 4-3 – Medium and High Expansion Foam Systems
  - F.M. Global – Data Sheet 4-12 – Foam Extinguishing Systems
- Gaseous systems
  - Inergen/ IG541 (Inert Gas)
  - Argonite/ IG55 (Inert Gas)
  - Nitrogen/ IG100 (Inert Gas)
  - FM20/ HFC-227ea (Hydrofluorocarbon)
  - Novec 1230/ FK-5-1-12 (PerFluorinated Ketones)
  - Pentafluoroethane / HFC-125
  - Carbon Dioxide (High/ Low pressure)
- Oxygen reduction systems
  - F.M. Global – Data Sheet 4-13 – Oxygen Reduction Systems
- Aerosol systems
  - FirePro (LPCB approved)

When seeking to protect a specific risk from fire, the decision of whether to use a suppression or extinguishing system and the choice of a specific technology type will depend on numerous factors relating to the protected materials and the environment in which they are located. RISCAuthority's series of Active Fire Protection Guides provides detailed summary information such as best practice, advantages, disadvantages, applicable standards, and safety requirements for each of the main system types.

Gaseous extinguishing systems

All gaseous extinguishing agents can pose toxicity and/or environmental risks, which should be understood when selecting a system. Some of these threats might be from the raw agent, and some from potential breakdown products once exposed to fire. The threat from most inert-type gaseous systems relate to the potential for asphyxiation. Whilst extinguishing concentrations can support life, consideration must be given to the potential for non-homogenous conditions, oxygen consumption by the fire, and exposure of people that are medically impaired. The threat from chemical agents can come from the raw agent toxicity, and their breakdown products in fire that can be highly toxic and impair a person's ability to escape. Carbon dioxide is inherently and immediately toxic at even low concentrations, and human exposure during discharge cannot be allowed.

Key safety related information is provided in each of the AFPGs, and is summarised here. It should be noted that when gaseous extinguishing systems are considered, RISCAuthority advice is to always consider inert gases over their chemical counterparts for reasons of design simplicity, limitation of consequential damage, safety, and long-term permissibility as environmental regulations change (see later).

It is important to note that 'inerting an atmosphere against fire and explosion' (preventing and protecting against a sustained ignition source) generally requires much higher concentrations of gaseous agent that will not be survivable. 'Inerting' a space against fire and explosion is a specialist design undertaking which is **out of scope of these documents**. Specific advice on design criteria is given in each section of the relevant standard for the specific agent considered. The term 'inert gas' must not be confused with 'inerting'. Chemical agents at an appropriate concentration can 'inert' the compartment's atmosphere against fire and explosion risks.

Gaseous extinguishing systems – toxicity considerations

Where concerns for safety are included in the guides, the figures presented can be reviewed against the table below relating to NOAEL and LOAEL values.

NOAEL – **N**o **O**bservable **A**dverse **E**ffects **L**evel – the highest concentration of a gas which should not adversely effect people that come into contact with it.

LOAEL – **L**owest **O**bservable **A**dverse **E**ffects **L**evel – the lowest concentration of a gas that has been reported to cause adverse health effects in people or animals.

Agent	Design Concentration (%)	NOAEL (%)	LOAEL (%)	Occupied Space (Y/N)	Global Warming Potential	Ozone Depletion Potential	Notes
Inergen	37-42	43	52	Y	0	0	N/A
Argonite	42-47	43	52	Y	0	0	1
Nitrogen	37-42	43	52	Y	0	0	N/A
FM200	8-9	9	10.5	Y	3220	0	N/A
Novec 1230	5-6	10	>10	Y	1	0	N/A
HFC-125	10-12	7.5	10	N	3500	0	2
CO2	34-50	3	10	N	0	0	3

Notes:

1. Argonite has a limited exposure time of 3 minutes within the compartment. The design concentration is greater than NOAEL.
2. HFC-125 is not suitable for occupied spaces. The design concentration is greater than NOAEL.
3. CO2 is a toxic gas; death will be very rapid if exposure occurs at the design concentration.

Gaseous extinguishing systems – environmental considerations/F-gas Regulations

F-gases are gases that contain fluorine. There are a range of these gases which include hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulphur hexafluoride (SF6) and have a global warming potential greater than one. Some of these gases are commonly found in chemical gaseous suppression systems.

Regulation (EU) No 517/2014 on fluorinated greenhouse gases (the F-gas Regulations) is in place to protect the ozone layer and mitigate climate change. This will be achieved by phasing down the amount of HFC that can be placed on the EU market by slowly reducing quotas permitted to HFC producers and importers.

The UK has international obligations under the UN Montreal Protocol on Substances that deplete the ozone layer (the Montreal Protocol). The regulation bans the use of F-Gas in certain applications, and sets out the requirements for strict service and maintenance of systems containing these gases, together with leak detection requirements. Any company or technician involved in this activity will be required to be certified, trained, and hold a valid F-Gas certificate.

Gaseous extinguishing systems – enclosure integrity

Protection of compartments with gaseous systems demand that the compartment is well sealed and then provided with a device suitable for venting overpressures during agent discharge, but will reseat to hold the column pressure of gas for the required hold time. For inert gases, the compartment must vent around 40% of its volume in 1 minute. Chemical agents typically must vent around 10% of the compartment's volume in 10 seconds. Inert agents produce positive pressures only, whilst chemical agents can produce both positive and negative pressures on discharge as the liquid agents flash evaporate to gas. The ventilation devices should be positioned and ducted to prevent exposure of personnel and other areas to the fire/agent efflux. Failure to seal the compartment, and then install the correct ventilation device, can result in destruction of the compartment boundaries, failure to extinguish the fire, huge hydrogen fluoride generation (chemical agents only), unintended contamination of adjacent areas and personal to raw agent, toxic agent derivates, and toxic fire products.

Gaseous extinguishing systems – types of gases and their modes of operation

The different gaseous extinguishing agents can crudely be categorised as:

- chemical inhibitors (halons)
- inert
- chemical agents
- carbon dioxide.

Chemical inhibitors

The most famously effective (but now outlawed under the terms of the Montreal Protocol) gaseous extinguishing agents were the halons. These were chemical inhibitors that directly affected the chemistry of combustion. None of the modern chemical agents operate to the same degree by this mechanism.

Inert agents

Inert gaseous agents operate by displacing oxygen from the compartment to a point where combustion can no longer be supported. Working with the fire to reduce oxygen, when correctly designed these can provide robust protection with few safety or environmental issues.

Chemical agents

Chemical agents have large complex fluorine containing-molecules that remove heat from the fire as they are broken down to a point where combustion can no longer be supported. For some agents, a small component of chemical inhibition may also take place. A by-product of this process is hydrogen fluoride and other chemicals, which being highly toxic to personnel and corrosive to equipment, needs careful consideration against the protection ambition.

Carbon dioxide

Carbon dioxide is considered separately to the other gases because of its inherent toxicity at extinguishing concentration. Whilst working in the same way as an inert gas, the primary risk of which is asphyxiation if concentrations should fall below design values, carbon dioxide is fundamentally toxic to humans (after a key excretion of the body via the lungs). It is a very effective extinguishing agent and best used for the protection of compartments too small to accommodate people.

Water-based active fire protection systems – toxicity considerations

The key safety issues pertinent to water-based fire protection systems are:

- legionella, from stored and stagnated water supplies
- deep lung penetration of droplets during exposure (watermist systems)
- inhalation of firefighting additives, such as foam and anti-corrosion agents.

Interlocks and alarm notifications

The activation of any active fire protection system should additionally:

- raise a local alarm
- be connected to the main building's alarm system
- if a 'suppression system' (further actions required to end the fire event) the alarm should be connected to the local fire and rescue service or alarm receiving centre
- isolate all fuels in the location of the fire (oil, gas, electricity, etc.)
- stop all ventilation in the area of the fire (unless it is required as part of the overall fire safety management plan)
- stop all conveyancing systems (such as conveyor belts) which may act to physically spread fire.

Associated Active Fire Protection Guides (AFPG)

AFPG-01 *Active Fire Protection Technology Document*
AFPG-02 *Watermist*
AFPG-03 *Inergen/IG541*
AFPG-04 *Novec 1230*
AFPG-05 *Argonite/IG55*
AFPG-06 *Nitrogen/IG100*
AFPG-07 *FM200*
AFPG-08 *Pentafluoroethane/HFC-125*
AFPG-09 *Carbon Dioxide*
AFPG-10 *Oxygen Reduction* (due soon)
AFPG-11 *Aerosol Fire Protection* (due soon)