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Guidance on

# Selection of Fire Protection Systems for Data Centers

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## FOREWORD

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*Note: The English version of this document is the approved Euralarm reference document.*



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# 1 INTRODUCTION

Data centers are becoming increasingly vital. The reasons for this are numerous:

- Digital Transformation: More and more companies are digitizing their processes and services, leading to a significant increase in data production. Data centers are crucial for storing, processing, and securing this data.
- Cloud Computing: The growing use of cloud services for storage, computing power, and applications is driving up demand for data center capacity, as they provide the infrastructure for cloud providers.
- Big Data and Analytics: Companies are increasingly using data analytics to gain insights into their customers, markets, and processes. Data centers play a crucial role in storing and processing these large volumes of data.
- Artificial Intelligence and Machine Learning: The development of AI and ML technologies requires enormous computational power and storage resources, provided by data centers.
- Internet of Things (IoT): With the increasing proliferation of connected devices, both companies and consumers are generating a growing amount of IoT data that needs to be stored, processed, and analysed.

This means that the demand for data center services will continue to rise sharply as digitization and the need for data processing and storage increase in all areas of life and business. Estimates and forecasts suggest that the annual growth of the data center market in the coming years could be in the double-digit percentage range.

For the mentioned data processing applications, costly technological equipment is required and high availability often expected. This, along with the need to protect often valuable, and sometimes irreplaceable data, underscores the crucial role of fire protection in data centers. A fire can lead not only to data loss but also to significant financial and reputational damage, downtime, and potentially even loss of life.

In addition to fundamental structural and organisational fire protection measures, technical fire protection plays a crucial role. The key elements of technical fire protection include:

- Automatic fire detection systems that can alert early to potential fires, allowing action to be taken before the fire develops.
- Automatic fire sprinkler systems, suppression systems, and gas extinguishing systems which can contain and/or extinguish fires before they escalate and cause catastrophic damage.

In addition to these technical measures, it is important for data center staff to undergo regular fire safety training, and clear incident response plans and evacuation procedures should be in place to enable quick and effective action in case of emergency.

Technological change in the way modern data centers are designed and used is ever evolving. From the way data is processed, speed of this, and physical location of the data center. Contemporary approaches strive to improve the cost of operations, Power Usage Effectiveness (PUE), for example cooling used to be recirculatory units but now could comprise free cooling, adiabatic cooling, liquid cooling, etc. This alone can radically change how a fire must be detected as well as how it is fought.

For example, modern approaches of adding aisle containment to prevent cross contamination of cool supply air with waste heat will change how detection and protection must operate.

# 2 SCOPE

This Euralarm guidance document provides insight on aspects to consider and some of the options available when protecting data centers.

It will aid in the understanding of how protection objectives can differ, client to client, region to region, and assist in the practical application needed for any specific circumstance. There is no one-size-fits-all, but this will allow insight as to the differences to establish what is optimum for you.

This guidance is written for data center designers, operators and those providing fire protection to this type of application.

It is presumed the reader knows the importance of fire protection and is seeking clarity about the implications of one solution over another.

This guidance will not explain about the difference between a Tier I or Tier IV but will identify issues that might arise if one fire protection approach is selected over another. It is intended to help the reader understand what is relevant to them and their specific application.

NOTES:

1) The use of Li-Ion energy storage is rapidly evolving and is not addressed in this paper. Li-Ion presents unusual challenges when in Thermal Runaway (TR). The approaches of this paper will apply to a fire, elsewhere, to prevent Li-Ion battery involvement. Where the fire is Li-Ion in TR, that requires special consideration including the amount of Li-Ion, its configuration, the overall volume and ventilation and proximity to other critical assets, etc. Please refer to specific information about Li-Ion protection.
2) Immersion and liquid cooling requires the designer to engineer a solution specific to the immersion/liquid cooling application and apply these principles to the general requirements; it is presumed immersion/liquid cooling will only apply to part of the IT system and other processes, cabling and infrastructure will still require conventional air cooling.

## 3 REGULATIONS AND STANDARDS

Within Europe, basic minimum, sometimes legal, requirements are set (e.g. CPR, PED, WEEE, RoHS, etc). From this a product Standard can result, e.g. EN 54 series of standards for fire detection and alarm, EN 12094 series of standards for fixed firefighting systems components, up to a system standard, such as EN 15004, but not all are mandatory.

Furthermore, you might have an American entity, be this the enterprise itself, parent company or the insurer, which calls for an American standard, such as NFPA 75 and other NFPA system design standards.

This latter point can be significant. If a sprinkler system is mandated in the USA and a water mist system is considered a suitable compromise between a sprinkler system and a gaseous extinguishing system, whilst an Authority Having Jurisdiction (AHJ) may accept that compromise in some cases, the AHJ's needs and viewpoints are probably very different to that of the Business Continuity Manager. I.e. ensuring structural safety for evacuation of personnel, and firefighting attendance is not the same as zero interruption and full business-as-usual availability.

Wrongly an enterprise business may look at a hyperscale data center and presume they know what is best. It may be best, or at least barely acceptable, for the hyperscale, but their size and spread offers resilience that any partial loss may present no service outage to their users – this is unlikely for an enterprise or tenant within hosted Co-Location space.

BS 6266, a code of practice in the United Kingdom reminds us of the extensive use of fire protection systems in electronic installations arises not from a high probability of fire, nor from a significant hazard to life, but from the consequences of fire loss.

Each physical location may have national and regional rules to follow too. This may be driven by insurers, Fire & Rescue Services (FRS)/fire brigades, or a need due to local hazards, such as an increased earthquake risk.

This guidance does not conclude which is best, but will identify points worth considering, to improve chances of surviving a fire and meeting your business protection objectives.

# 4 PROTECTION CONSIDERATIONS

Crucial to devising any fire protection strategy is to understand what unacceptable interruption or loss is.

## 4.1 PROTECTION GOALS

In simplified form, protection targets outline the maximum expected level of damage deemed acceptable in the event of a fire. The minimum protection target is usually set by the authorities responsible for installation and operation, it is typically supplemented by the protection targets of the system operator, such as:

- Acceptable extent of damage,
- Protection of the facility itself,
- Protection of the environment,
- Ensuring fast return to service.

In general, the relevant building codes and regulations introduced under building law must be complied with. The building owner or operator is responsible for ensuring that the conditions of the respective building code/regulation/permit are complied with. The measures for personal protection, availability, protection of material assets and environmental protection, cannot be so easily generalized.

## 4.2 DATA CENTER TIER LEVEL CLASSIFICATION

The growing need for more computational power, sometimes supplementary or ad-hoc, as well as possibly increased availability requirements, is a driving force behind organizations' reliance on data centers, including those provided by third-parties. The uptime and performance delivered by these facilities should allow a business to thrive without fear of a system failure or natural disaster derailing this objective. The Uptime Institute's Tier Classification System can provide guidance on balancing risk tolerance and budget regarding power, cooling and fault tolerance but the unpredictability of fire does not readily fit the framework.

Tier classification uptime can be converted to downtime in hours per year, however fire protection measures will differ regarding how the incident, intervention and resumption of business-as-usual unfolds. For instance, a gaseous system could be deployed without any service outage, whereas a sprinkler system operating may require all power to be removed and several days of drying before business operations can restart – which might be overlooked yet needs serious consideration if remaining functional is imperative.

## 4.3 EVOLVING CHALLENGES

In the 1980's, when an increased dependence on computers really started, it was commonplace for a system to comprise point type smoke detectors on the ceiling. The air flow within these spaces was quite slow, so upon the first detector operating the air conditioning would likely be stopped. This allowed undiluted smoke to rise, under convection, and enter a second detector, providing coincidence detection. This coincidence operation then normally triggered the deployment of a halon system as well as removal of all power from the protected assets.

How things have changed. Nowadays it is not possible to decelerate or still the air, as the I.T. asset will rapidly overheat, and therefore if continued cooling is required, and higher airflow likely, a different detection methodology may be necessary. There are many sources of information pertaining to this, for example the FIA guidance document on Fire Detection in High-Airflow-Environments, VdS 3152, etc.

Similarly, there has been ongoing work into understanding how continued operations can best be served, and perhaps the air flow utilised to aid protection or at least evaluated to check it does not compromise this. For example the latest research undertaken by the FSSA & FIA and corresponding guidance from Euralarm.

Without doubt, anyone evaluating requirements must first understand what level of fire protection they require; whether they require fire control, suppression or extinguishing.

- **Fire control**: systems such as sprinklers release water onto the affected area to control growth. These systems are effective for containing fires and preventing their spread, and sometimes may even result in extinguishing where there is adequate flow and no shielding.
- **Fire suppression**: systems like water mist effectively reduce the fire intensity, suppressing growth. This suppression is a reduction in heat output (or an increase in localized heat consumption) but is reliant on the water mist getting to the seat of the fire. Notably, suppression systems typically have a minimum run time, to provide control and suppression, until FRS intervention and final manual extinguishment.
- **Fire extinguishing**: exemplified by gaseous systems, are highly effective and leave no residue, making them suitable for use in sensitive environments and where full cover, i.e. extinguishant penetration of the I.T. equipment, is necessary and so the business can operate uninterrupted.

The cost of the system, in build and ownership, plus the consequence of any deployment is different for each system. One must also consider the timeline of an event unfolding, through to full recovery to business-as-usual.

Any outage, be this power or cooling, can have disastrous consequences such as irreparable data loss as well as significant effort to try to recover and reinstate data.

Within a data center it may be that different technologies are better suited for each risk.

For example, the whitespace. Where data processing is undertaken, high air flows are likely, the fire will likely be shielded inside its I.T. housing, possibly further confined within aisle containment, and the cabling and infrastructure (be this power or data) is itself as critical as the server and equipment. In these applications, a total flooding gaseous system is well suited. The racks and aisle containment would shield a fire from sprinkler droplets. The high airflow would likely have a detrimental effect on the delivery of smaller water mist droplets, whereas the study by the FIA & FSSA indicate this scenario can be advantageous to a gaseous system.

For the grey space, those support functions which may have redundancy in design, a water mist system may be better than a gaseous system. For example, a battery room or UPS maybe more tolerant of some wetting, and the likely difference between extinguishing and suppression may be insignificant with regards to the availability of the I.T. asset. Of course, if a gaseous system is used for the whitespace, and selector valves are used to protect multiple areas from a single container bank, then the gaseous system may have the upper hand. Conversely, for water mist, which may be optimal for generator protection with large open louvres, and therefore if a water mist system is installed then that can serve the tertiary parts of the building such as office and churn space which might otherwise have a sprinkler system or no protection whatsoever.

One can see that compromise can be achieved, be this driven by price, available space, or the preferred methodology of fire protection. But this compromise will often be driven by the client’s attitude to risk, allowed interruption and required availability, whilst also meeting the AHJs requirements which are likely to be lower and solely focus on building safety and life protection.

### 4.4 SEQUENCE OF EVENTS

A site-specific fire strategy should be aligned to the business continuity plan. This will often be over and above that called for in regulation, which often has a focus on the sole preservation of life. Extra measures that may be considered are more in line with property protection and/or business continuity. Prevention and early intervention can mitigate an incident, and various scenarios should be considered.

The following gives some examples which may be considered on a timeline and used to develop the correct approach for a specific client or need.

**Early detection**

Using the right type of detection, correctly placed, is paramount – be this to trigger manual intervention or for automated cause and effect.

Many FRS document system failures which can include:

- Products of combustion, i.e. smoke, failed to reach the detector. This may be a poorly sited detector or installed per code but compromised because of the airflow required for I.T. cooling.
- Incorrect type of detector. This may include the type of smoke detector not well-suited to the combustible or heat setting to the prevailing conditions, e.g. again consider airflow and smoke dispersal/dilution or cooling for heat operated devices.

Do consider balancing alarm sensitivity to control unwanted alarms which may alter FRS response or induce alarm apathy.

**Manual intervention**

What intervention is expected, safe and permitted?

Can early detection trigger manual intervention or improved automation?

- Can high sensitivity detection in a high airflow environment be used to temporarily still or decelerate the airflow if point type detection needs to operate, or to allow first responders improved ability to visually locate the seat of the fire?
- Can the alarm initiate I.T. scrutiny to aid identification of a troublesome component or system part? For example, for isolation or to guide attending first responders?
- Can an alarm be complemented with other means to initiate (manually or not) shut down of a system or sub-system to prevent the situation escalating, or to commence a graceful shutdown so disruption and data loss is minimised?

Are first responders allowed to attend an alarm and intervene?

- Can they be relied upon to manually activate a protection system for earlier operation if that would lead to a better outcome?
- Can their intervention avert unwanted system operation if manual firefighting is possible.

Note: as human behaviour can be inconsistent, stakeholders and insurers may assume or require automatic protection so a system should not be in manual-only mode without good cause but changing this to manual whilst attempting intervention could be viable.

What may be required to minimize the need for FRS intervention or safeguard the business from their operations?

- If the FRS will require all power to be removed from a protected space, prior to entry, is this understood?
- Does one fire protection technology eliminate this risk or change how this is performed, versus another?
- How is it enacted? By relay on system operation, on a timer with cause and effect, via Emergency Power Off (EPO) "kill" buttons?

**Automated cause and effect intervention**

What of the above can be automated.

- Could an alarm, initiated from within a secure area, coordinate with the security system to allow certain first responders faster access, without posing a security weakness? For example, softening of two / multi factor authentication (2FA) such as pin and biometric for specific personnel.
- Can an alarm automate other means of fire evaluation such as CCTV and a predefined workflow for remote assessment?
- Will the detection modify air movement and if so, what period of time is permitted to assist without risk to the I.T. equipment? E.g. to ensure correct sprinkler or water mist head operation, impacting the seat of the fire.
- Is there a requirement for automated power-off or will this be necessary because of the type of fire protection system to be used? If so, can a graceful shutdown be automated, or personnel alerted to commence this procedure remotely.

Is coincidence operation employed where more than one device is used to reduce false alarms and avert unwanted system operation.

- What is used for coincidence alarm?
- What measures can be used to complement this, to aid outcomes in both a fire and unwanted alarm situation?

**<u>FRS attendance</u>**

What can be expected of the FRS?

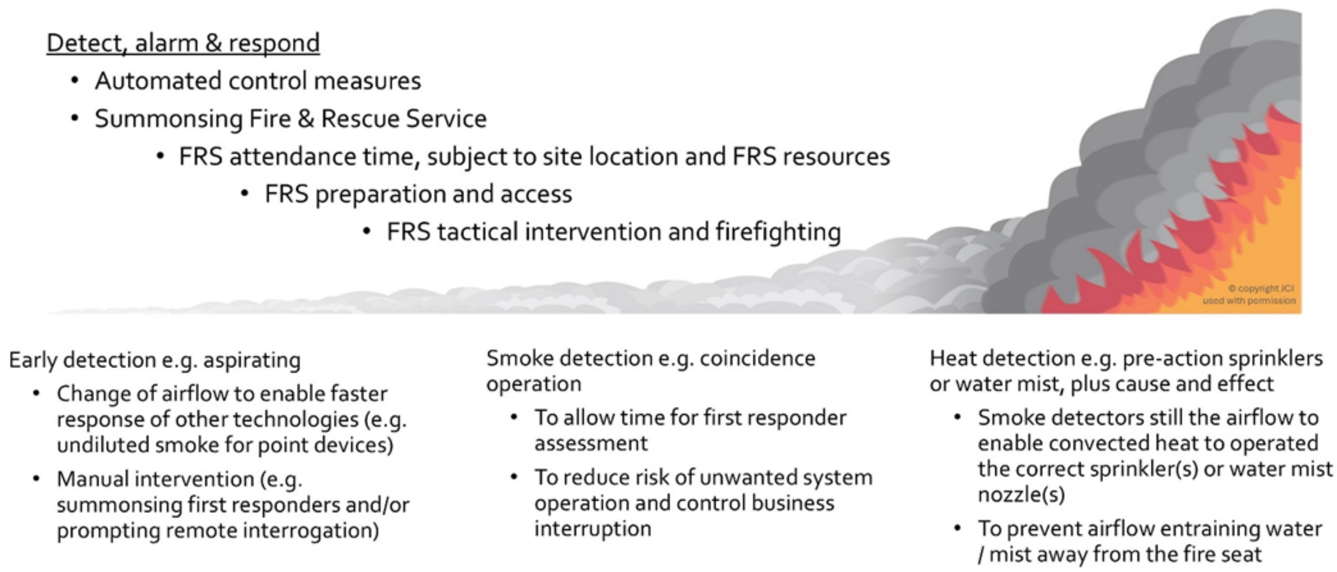
- What is their predicted attendance time?
- What is then required for preparation, on arrival to site, prior to tactical operations?
- How are they afforded access to the protected area? E.g. do they need an escort to navigate the site as well as bypass the security inherent to a Data Center?
- How long is the protection philosophy required to perform with respect to the FRS attendance/intervention and what additional losses might occur in this time? Is that still acceptable?
- Can other measures be used to avoid unwanted impact of the FRS? E.g. could a gaseous fire extinguishing system with remote I.T. diagnostics and facility interrogation establish the seat of the fire and apply amelioration without the FRS entering.

**<u>FRS intervention</u>**

Will the FRS be aware there is a protection measure in place?

- Is the FRS familiar with the system and duly informed of its specifics? For example, a total flooding extinguishing system using an inert gas may have hours of protection, whereas a water sprinkler or mist system is a control or suppression measure that requires more prompt FRS intervention.
- Does the protection system change the firefighting methodology the FRS will use? E.g. a gaseous system will require FRS Breathing Apparatus (BA) but not present an electrocution risk that a water-based approach might; condensed aerosol systems will cause obscuration possibly concealing exposed wires where insulation has burnt through, etc. The FRS may not need nor mandate power removal in all these cases, and that must be considered with respect to local code and through dialogue with the authority having jurisdiction and FRS.

The above can be exampled against and unfolding situation as follows:




Some of these will be considered in greater depth in the next section, allowing more detailed comparison than the above example.

# 5 FIRE PROTECTION SOLUTIONS

Automatic systems will have a design objective of either fire control, suppression or extinguishing, as discussed in 4.3. Systems protect objects, rooms or entire buildings from fires and their consequences. The technologies used for this purpose are liquid (water), two-phase (foam), solid (powder), gaseous (gases) or condensed aerosols. Depending on the medium used, heat and/or oxygen is 'displaced' from the fire, as in separated from the fuel. E.g. for gaseous extinguishants, their suppressive effect begins during the flooding time, culminating in an extinguishing concentration which persists while the gas remains within the protected space. Intervention and activation of the fire protection system must accordingly be harmonized with the fire strategy and technology employed.

**Key issue in any fire protection system:** Each layout and the correct discharge is decisive for the reliable functioning of the fire protection system. Of course, not only layout and design of a system, but also the correct installation, the use of approved systems[1] and timely maintenance by appropriately trained and certified staff[2] are key issues.

Additional consideration points include space needs, cost, proximity, etc.

The following is used to example where specific fire protection technologies may be deemed better suited, relating to the detailed information which follows.

| **Fire Protection Technology** | | **Application** | | | |
|---|---|---|---|---|---|
| What technology | How they work | White space / servers / I.T. | Grey space e.g. power | Churn space e.g. corridors | Other ordinary space e.g. offices |
| Sprinkler | Sprinkler bulbs normally operate on heat of a fire and set to drench that area. This provides wetting of the fire itself and pre-wetting of the adjacent assets, preventing spread. They are not well suited to shielded equipment. |  |  |  |  |
| Water mist | Like a sprinkler, provides wetting but also cooling. Conversion to steam, to displace oxygen, needs a sizeable fire, e.g. >0.5 MW, but this makes them very well suited for hazards like diesel generator sets. |  |  |  |  |
| Gaseous | Normally deployed on operation of coincidence detection, or manually. Total flooding will penetrate equipment, cable bundles, etc and is not affected by shallow voids and shielding. Requires a degree of airtightness. |  |  |  |  |
| Oxygen reduction systems (low $O_2$) | Modifies the atmosphere to avoid fires, targeting <15% $O_2$, but that has a consequence for humans in normal operation. Does require a very high degree of airtightness. |  |  |  |  |
| Condensed aerosols | Aerosols can absorb heat, reduce oxygen and chemically interrupt the combustion process. |  |  |  |  |
| Other technologies* | |  |  |  |  |

* This paper shall focus on the more suitable technologies. For example, foam may be suited to a generator set but not suited beyond that so not considered beyond this point.

[1] See **Euralarm-Guidance on approved system versus approved components** – publicly available: see: https://www.euralarm.org/resource/guidance-on-gaseous-systems-approved-system-versus-approved-components.html

[2] See Euralarm guidance papers on "**Maintenance of extinguishing systems/equipment**" – published Q4/2021 and "**Maintenance of condensed aerosol fire extinguishing systems"** – published Q2/2023

The following key may be used, however this needs to be considered with regards to the specific stakeholder protection objectives:

| | |
|---|---|
| ☹ | Either unsuitable or less suitable when compared to alternative options. |
| 😐 | Better suited, but still some possible compromises that need to be considered. |
| ☺ | Most suitable, in general terms. |

## 6 OPERATIONAL FIRE SAFETY

Historically fire protection of data centers included stopping I.T. operations and deploying a system to extinguish the fire. Nowadays the challenge is very different. Rarely is a process allowed to stop and therefore the system needs to be appropriate for that as well as the strategy address the potential for reignition as the power is preferably not interrupted.

Certainly, the approach for one client, such as a hyperscale, may be wholly unsuited to another, such as a multi-tenant hosted (co-lo) space or client specific enterprise data center.

It is therefore imperative that the site-specific fire protection strategy considers whether the objective is fire control, suppression or extinguishing, and what is to happen during system deployment and thereafter.

Let's consider the stages of an incident:

- Pre-fire / Business-as-usual
- During a fire
  - Incipient burn (smouldering)
  - Flaming combustion
  - System deployment
  - Fire brigade / FRS intervention
- Immediate aftermath / post deployment of the fire protection system
- Resumption of business as usual
- Protection system reinstatement.

### 6.1 PRE – FIRE / BUSINESS AS USUAL

It is important to consider how a system may affect normal business operations, prior to a fire.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | ☺ | ☺ No implications on persons operating within the protected areas. |
| Water mist | ☺ | ☺ No implications on persons operating within the protected areas. |
| Gaseous | ☺ | ☺ Usually, as safe concentration, can be left in the automatic mode of operation with no implications on persons operating within the protected areas.<br>😐 Some clients or jurisdictions may have differing rules. Stakeholder and insurer engagement is advised if planning any impairment to automatic operation. |
| Oxygen reduction systems (low $O_2$) | 😐 | 😐 Whilst the target residual oxygen level is intended to be safe, some clients / jurisdictions may class as a "confined space" and call for a safe system of work which may include a banksman, such as a second person required for all plant patrols, or resumption of oxygen when working in the protected area which adds to the cost of system operation (restoration of cover), as well as a loss of cover when persons at work – which is when a fire is potentially most likely. |
| Condensed aerosols | 😐 | 😐 Operation will cause obscuration and possibly affect breathing, subject to the formulation / chemistry, and users may require system incapacitation when the protected area is occupied, losing all cover until reinstatement is affected. |

## 6.2 DURING A FIRE

Different combustibles (fuels) will have different fire development and growth rates. Electronics can be expected to smoulder and smoke prior to burning whereas diesel is likely to immediately jump to flaming combustion. Detection needs to be appropriate for this but also consider when intervention is likely and what can be expected to be achieved.

Detection should prompt immediate alarm and initiation of evacuation measures per a predefined evacuation plan. Deployment of first responders - trained personnel - to provide first aid firefighting and early intervention, such as possibly combat the spread of the fire, if this is safely possible, manually deploy any automatic system, etc., as well as act should this be an unwanted alarm. This will change subject to the type of detection and stage of evolution, as well as the fire protection approach employed.

### 6.2.1 Incipient burn

Electronics and similar materials that can be expected to smoulder and smoke prior to the outbreak of flames will likely have an incipient stage.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | ☹ | ☹ Can be used on a fully open (deluge) system, but if bulb type nozzles then they will not operate, as not enough heat is generated yet. |
| Water mist | 😐 | ☹ 😐 Can be used on a fully open (deluge) system, but if bulb type nozzles then they will not operate, as not enough heat is generated yet. |
| Gaseous | ☺ | ☺ Can be deployed and will prevent fire growth, eliminating flaming combustion from occurring. |
| Oxygen reduction systems (low $O_2$) | ☺ | ☺ Prevents the evolution to flaming combustion, if the correct oxygen concentration is maintained. |
| Condensed aerosols | ☺ | ☺ Can be deployed and will prevent fire growth, eliminating flaming combustion from occurring. |

### 6.2.2 Flaming combustion

If an electrical issue has evolved through the incipient stage, flaming combustion will follow. For class B (liquid) hazards, such as a diesel generator set, fires will lack an incipient stage and fire growth will likely be far quicker once ignited.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | 😐 | 😊 Suited where fire loss can be entertained and control is allowed until human intervention for full extinguishing (e.g. first responder or brigade / FRS), such as office space.<br>😐 Will require sufficient flame size and heat to cause the sprinkler head to operate, unless a deluge (open) system is operated automatically by detection. Sprinklers afford good fire control, to prevent the spread of fire. They are sometimes successful at extinguishing, but this requires deployment from the sprinkler head directly onto the seat of the fire. |
| Water mist | 😐 | 😊 Suited to areas where rapid fire growth is expected and suppression (without guaranteed extinguishing) acceptable, such as protecting a diesel generator set.<br>😐 Will require sufficient flame size and heat to cause the water mist nozzle to operate, unless a deluge (open) system which is operated automatically by detection. Water mist affords good fire control, to prevent the spread of fire, plus suppression. They can be successful at extinguishing, but this is not certain and may be application and manufacturer specific. |
| Gaseous | 😊 | 😊 Effective.<br>😐 Where a large fire is expected, in relation to the protected area, halocarbon agents will suffer thermal decomposition, but this must be considered to the fire damage itself and fire effluent; inert gases are unaffected this way. |
| Oxygen reduction systems (low $O_2$) | 😊 | 😊 Effective.<br>😐 If the correct oxygen concentration has been maintained within the protected area, then flaming combustion should not be possible. If the $O_2$ concentration is compromised, then the fire growth will be reduced subject to the extent of compromise. |
| Condensed aerosols | 😊 | 😊 Effective.<br>😐 Depending on the chemical formulation of the aerosol, products generated must be considered (in addition to the fire damage itself and fire effluent). |

### 6.2.3 System deployment

Following activation the system will operate. The below should be considered

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | 😐 | 😐 Will require sprinkler head discharge directly onto the seat of the fire.<br>Likely to only offer control or possibly suppression, in most Data Center applications.<br>Will result in flow of water so there will be water damage. The system run time until FRS intervention should be considered. For many jurisdictions and also remote areas this may require dedicated water storage for the sprinkler system, and/or an increased amount.<br>Some authorities may also require containment and management of any fire run-off water arising from a sprinkler system operating.<br>☹️ In I.T. environments will likely need power removal or risk of resulting damage. |
| Water mist | 😐 | 😐 Will require sufficient flame size and heat to cause the water mist head to operate, unless a deluge (open) system which is operated automatically by detection.<br>😐 Will require the discharge to affect the seat of the fire.<br>Unless a deluge system, the operation in an I.T. environment with high airflow is unlikely to result in the discharged mist being delivered to the seat of the fire, more likely entrained in the high airflow and away from the fire.<br>☹️ In I.T. environments will likely need power removal or risk of resulting damage. |
| Gaseous | 😊 | 😊 Effective. Can allow continued I.T. operations and need not have power removal, however the cause of the fire will still need to be ameliorated during the period of protection.<br>😐 Some systems can result in noise on discharge which can affect I.T. equipment using hard disc drives (HDDs); where HDDs are present, then noise abating nozzles or other measures outlined in EN 15004-1 should be considered. |
| Oxygen reduction systems (low $O_2$) | 😊 | 😊 Effective. Can allow continued I.T. operations and need not have power removal, however the cause of the fire will still need to be ameliorated. |

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Condensed aerosols | 😊 | 😊 Effective. Can allow continued I.T. operations and need not have power removal, however the cause of the fire will still need to be ameliorated during the period of protection.<br>😐 Localized heat generation proximate to the aerosol generator.<br>😐 Obscuration will occur which will affect personnel escaping and FRS intervention. |

### 6.2.4 Fire brigade / FRS intervention

What can the FRS expect to find at the location and what system measures might need consideration to assist them or prevent avoidable damage.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | 😐 | 😐 FRS will need to enter immediately to assess the state of the fire and ensure extinguishment. The presence of water creates an electrocution risk, so cessation of power will likely be required if not automated. |
| Water mist | 😐 | 😐 FRS will need to enter immediately to assess the state of the fire and ensure extinguishment. The presence of water creates an electrocution risk, so cessation of power will likely be required if not automated. |
| Gaseous | 😊 | 😊 FRS, wearing breathing apparatus, can safely intervene whilst protection is still afforded, allowing assessment of the fire cause. |
| Oxygen reduction systems (low $O_2$) | 😊 | 😊 FRS, wearing breathing apparatus, can safely intervene whilst protection is still afforded, allowing assessment of the fire cause. |
| Condensed aerosols | 😊 | 😊 FRS, wearing breathing apparatus, can safely intervene whilst protection is still afforded, allowing assessment of the fire cause.<br>😐 Obscuration will occur which will affect FRS intervention. |

### 6.2.5 Immediate aftermath / post deployment of the fire protection system.

What actions need to be taken after the fire event has been resolved and FRS has released access. The cause of the fire must be identified and resolved before normal business operations can resume.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | 😐 | 😐 Loss of fire protection cover until operated sprinkler head(s) is replaced, valves reset and the system reinstated. If a dry-pipe system, then further remedial measures are required, wet-pipe systems may need repriming, etc.<br>System operation may remove partial or full site cover subject to the sprinkler design. |
| Water mist | 😐 | 😐 Loss of fire protection cover until the operated water mist nozzle(s) is replaced, and the system recharged.<br>Pipework may require purging.<br>System operation may remove partial or full site cover subject to the design. |
| Gaseous | 😐 | 😐 Ventilation to remove agent and reinstate normal air.<br>Loss of protection until agent storage is recharged, unless a connected reserve is present. |
| Oxygen reduction systems (low $O_2$) | 😊 | 😊 No loss of cover, aside of action from the FRS.<br>Possibly need to purge the air to remove airborne fire by-products still contained within the protected space. |
| Condensed aerosols | 😐 | 😐 Ventilation to remove airborne agent and reinstate normal air and other clean-up on equipment.<br>Loss of protection until aerosol generator units are replaced. |

### 6.2.6 Resumption of business as usual

What actions are needed to ensure the business operation can be resumed including verification of equipment performance not being damaged.

When I.T. has been powered off then a restart is required. Where there was not a graceful shutdown, then recovery will be required plus assessment of any corrupted or lost data.

| What technology | Suitability | Pros and Cons |
|---|---|---|
| Sprinkler | | Clean up and drying will be required prior to electrical reinstatement.<br>Any system stopped during the fire event will require restart.<br>Data loss arising from abrupt power removal will need to be established and remediation applied. |
| Water mist | | Clean up and drying will be required prior to electrical reinstatement.<br>Any system stopped during the fire event will require restart.<br>Data loss arising from abrupt power removal will need to be established and remediation applied. |
| Gaseous | | Possibility of no interruption of service, beyond the alarm initiating component, if acceptably to AHJ.<br>Establish whether acoustic interference affected continued I.T. operation throughout the discharge.<br>If power was removed, either by FRS or local requirement, then systems will require restart and any data loss arising from abrupt power removal will need to be established and remediation applied. |
| Oxygen reduction systems (low $O_2$) | | Possibility of no interruption of service, beyond the alarm initiating component, if acceptably to AHJ.<br>If power was removed, either by FRS or local requirement, then systems will require restart and any data loss arising from abrupt power removal will need to be established and remediation applied.<br>Reinstate low oxygen cover if purging was needed to remove airborne fire by-products still contained. |
| Condensed aerosols | | Cleaning is likely necessary, including all deposited extinguishant, plus any decontamination.<br>Establish whether chemical contamination affecting protected assets. Likely replace air handling filters.<br>If power was removed, either by FRS or local requirement, then systems will require restart and any data loss arising from abrupt power removal will need to be established and remediation applied. |

### 6.2.7 Protection System Reinstatement

Until the system is reinstated there is no protection, and stakeholders may require notification (insurers, users, etc), a fire-watch, and so on. All systems will require reset and reinstatement, from spares to service contract.

## 7 MANAGEMENT SUMMARY / CONCLUSIONS

This guidance note has discussed some of the many options to be considered, beyond the local minimum requirements of building and life protection, or that of limiting asset damage, and introduces concepts that help formulate an appropriate business continuity plan. Married to this should be an incident strategy which includes on-site first responders, the attending FRS and Information Technology (I.T.) Managers.

It is right that the system is designed to best protect the business and that sometimes needs a detailed understanding of the client's requirements which can differ greatly, even for neighbouring businesses.

In some cases, a well-defined strategy may require more than a single site-wide technology.

# 8 MATERIALS AND INFORMATION

| No. | *Document* |
|---|---|
| 1. | EN 54 series of standards for Fire detection and fire alarm systems |
| 2. | EN 12094 series of standards for Fixed firefighting systems - Components for gas extinguishing systems |
| 3. | EN 12845 Standard for the design, installation and maintenance of sprinkler systems |
| 4. | EN 14972 series of Standards for Water mist |
| 5. | EN 15004 series of standards for Fixed firefighting systems - Gas extinguishing systems |
| 6. | EN 50600-2-5 Information technology - Data centre facilities and infrastructures - Security systems |
| 7. | FM Global Property Loss Prevention Data Sheet 5-32 Data centers and related |
| 8. | NFPA 13 Standard for the Installation of Sprinkler Systems |
| 9. | NFPA 75 Standard for the Fire Protection of Information Technology Equipment |
| 10. | NFPA 750 Standard on Water Mist Fire Protection Systems |
| 11. | NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems |
| 12. | NFPA 2010 Standard for Fixed Aerosol Fire-Extinguishing Systems |
| 13. | VdS 3152 Cold and hot aisle containment - Fire protection requirements - Leaflet for loss prevention |
| 14. | Euralarm Guidance Document - Impact of High Airflow and Hot / Cold Aisle Containment on Gaseous Fire Extinguishing System Performance in Data Centers. Published Sept 2024.<br>Download Link |
| 15. | FIA Guidance Document – Fixed Gaseous Fire Extinguishing Systems - System actuation considerations<br>Published Sept 2020 by FIA (Fire Industry Association, www.fia.uk.com)<br>Download: Link |
| 16. | FIA Guidance Document – Fire Detection in High Airflow Environments Including Electronic Equipment Installations<br>Download: Link |
| 17. | FSSA/FIA-Research Report - Effect of High Airflow and Aisle Containment on Clean Agent System Performance in Data Centers - A Joint Study by the Fire Suppression Systems Association (USA) and the Fire Industry Association (UK)<br>Download: Link |

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