Fire Protection Association

RISCAuthority

ACTIVE FIRE PROTECTION GUIDE

MIGRATION OF NOVEC™ 1230 AND HFC GASEOUS EXTINGUISHING AGENTS TO ENVIRONMENTALLY ACCEPTABLE ALTERNATIVES

Summary

NOVEC™ 1230 is being voluntarily withdrawn from the market by its manufacturer 3M due to its classification as a 'forever chemical'. Whilst other manufacturers can supply FK-5-1-12 (the general name for NOVEC™ 1230) both EU and US environmental policy changes means its days are numbered for use in fire extinguishing systems. This guide, in association with other RISCAuthority AFPGs, describes potential candidate replacement options for consideration, and describes the specific features that might support the selection of one option over another. This guide is equally pertinent to the replacement of HFC agents which are similarly being phased out under F-Gas regulation owing to their greenhouse gas contribution.

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1 Background and scope

This document and the associated questionnaire are designed to assist with transition from dependency upon the gaseous extinguishing agent NOVEC™ 1230 from 3M (generic name: FK-5-1-12), who have announced that production of the agent will cease by the end of 2025. The decision to cease production stems from the agent being part of the PFAS (per- and polyfluoroalkyl) group of compounds that do not readily decompose naturally and can build up in soil, water, and the human body and as such are nicknamed a 'forever chemical'. This runs somewhat contrary to NOVEC™ 1230 advertising literature that states an atmospheric lifetime of just 5 days but this particular point will be explored no further here.

Current scientific research suggests that exposure to high levels of certain PFAS may lead to adverse health outcomes which include:

- Reproductive effects such as decreased fertility or increased high blood pressure in pregnant women.
- Developmental effects or delays in children, including low birth weight, accelerated puberty, bone variations, or behavioural changes.
- Increased risk of some cancers, including prostate, kidney, and testicular cancers.
- Reduced ability of the body's immune system to fight infections, including reduced vaccine response.
- Interference with the body's natural hormones.
- Increased cholesterol levels and/or risk of obesity.

This guidance is specific to the NOVEC™ 1230 3M product since the EPA (United States Environmental Protection Agency) is not currently recommending a ban on PFAS, so alternative sourcing of the agent from other suppliers remains an option since the patent to produce the chemical for fighting purposes expired some years ago. That said, future imposed restrictions on use are very likely in both the US and EU. PFAS are so widely used, and in such a variety of industries and applications, that the EPA approach centres on the following principles:

- Consider the lifecycle of PFAS
- Get upstream of the problem
- Hold polluters accountable
- Ensure science-based decision making
- Prioritise protection of disadvantaged communities.

The national authorities of Denmark, Germany, the Netherlands, Norway, and Sweden have submitted a proposal to ECHA (European Chemical Agency) to restrict per- and polyfluoroalkyl substances (PFASs) under REACH, the European Union's (EU) policy for chemical regulation 7. It is anticipated that these regulations will include FK-5-1-12.

The European Chemicals Agency (ECHA), an agency of the European Union, has defined a PFAS as: 's ubstances that contain at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I atom attached to it)' – a definition that NOVEC™ 1230 / FK-5-1-12 falls within.

NOVEC™ 1230 was introduced as an environmentally acceptable alternative to the HFC based gaseous agents, such as FM200 (HFC-227ea), FE13 (HFC-23), ECARO (HFC-125), which are being phased out under the EU's F-gas Regulation. The F-gas Regulation specifically seeks to minimise the impact of HFCs on climate change due to their high global warming potential (CO2 equivalent) by 2030.

Given that NOVEC™ 1230 and the HFC agents were often used in similar applications, the contents of this guide is relevant to the migration of all liquified chemical type fire extinguishing systems to more environmentally acceptable solutions.

2 Technical background

NOVEC™ 1230 (and HFC agents) are typically used to protect 'compartment' risks that include:

- Applications formerly protected by Halon
- Laboratories/telecommunication rooms
- Computer and server environments
- Control rooms/archive storage
- Class A, Class B and Class C Fires
- Electrical equipment (non-conductive)
- Ship building and oil platforms
- Engine rooms and transportation.

It is typically applied in total flood form to protect whole compartments, but can also be found in portable fire extinguishers, in-cabinet units, and in low pressure linear pneumatic heat detection tube type systems.

The firefighting action of NOVEC™ 1230 is one of cooling. It is a very heavy gas, 11 times heavier than air, which makes compartment design and control a particular feature of its use, particularly in respect of uncontrolled low level ventilation paths and position of the protected hazard.

Whilst gaseous agents of this type are often cited as 'Clean Agents' this is a bit of a misnomer. They may indeed inflict little damage to equipment on 'accidental' activation when there is no fire, but in the presence of a fire they do degrade in the flame to form highly corrosive hydrogen fluoride gas, and of course on discharge will mix up the contents of the compartment bringing down the smoke layer to contaminate all areas with other potentially toxic, conductive, and corrosive chemicals (fire breakdown products). As such, in many cases migration to other extinguishing systems may provide an opportunity to improve not only the environment credentials of the system, but also to reduce the potential for consequential damage to equipment and the generation of toxic atmospheres.

In developing a replacement strategy for NOVEC™ 1230 (or any HFC agent) there is a need to establish:

- What the protection application is
- What performance is required from the system
- How the agent is applied
- The properties of the enclosure (if a total-flood system)
- The role the system plays in the overall protection strategy

- Whether specific reasons drove the original selection over competing technologies
- What the sensitivities of the protected space to other firefighting media are.

Competing alternative technologies can include inert agents, carbon dioxide, condensed aerosol extinguishing systems, powder, watermist, and sprinklers (drenchers), although careful consideration must be given to specifying the protection objective in terms of whether fire extinguishment or suppression is needed. All gas systems are by definition 'extinguishing systems', implying that no other actions are required to terminate the fire event. They must extinguish the fire, and prevent re-ignition, and the same is true for powder and condensed aerosol extinguishing systems – failure to extinguish results in no residual benefit from the single shot discharge, fires may recover quickly, and, depending upon the agent may create an increased risk from toxic and corrosive agent breakdown products. Sprinkler (drencher) systems and watermist systems are typically 'suppression systems', designed to contain the fire and prevent spread for the duration of discharge until outside assistance arrives (normally the fire service), to finish the event. Replacement of an extinguishing gas system need not rule out migration to water-based systems, but the overall design will need to be augmented to include alarm raising and signalling for follow-on support.

It is highly unlikely that a drop-in bottle-fill replacement for NOVEC™ 1230 is possible except where an alternative source of FK-5-1-12 is found. Chemical type agents are designed to discharge within 10 seconds, and inert gas systems within 60 seconds. As such the pipework designs, sized to control the discharge rate, are very different and unlikely to be transferable.

3 Migration parameters

The historic advice from UK insurers on the selection of gaseous fire extinguishing systems has been to favour inert gaseous agents on account of their assured environmental credentials, human safety, not contributing the native fire toxicity, and robust extinguishing action – working with the fire to reduce oxygen. That said, as bottled, non-liquifiable gases it can be difficult or impossible to accommodate the space and weight requirements needed for some applications, principally in transport, and alternative solutions are needed. Carbon dioxide can reduce the storage requirement over other inert gases because it is stored as a pressurised liquid, but its inherent toxicity at firefighting concentrations limits it application to non-occupiable spaces, or larger spaces with strict access control.

The key design parameters to consider under a replacement strategy include:

- Class and type of risk – this will determine the amount and type of agent required.
- System storage and weight constraints – where this is an issue the options for replacing NOVEC™ 1230 and HFCs might be limited to continued use of FK-5-1-12 from an alternative supplier, or a switch to aerosol or powder technologies.
- Complexity of the risk geometry – gaseous and aerosol agents can protect significant 3D geometries from a few nozzles, whereas water-based systems might require a 2D coverage approach using more spray heads.
- Ability to control compartment ventilation – gaseous systems demand a high level of compartment sealing (post discharge), whereas water-based systems may be more tolerant of, or even immune, to ventilation.
- Sensitivity of the compartment contents to the raw agent, any breakdown products, post discharge residues, or sound/pressure (corrosion, conduction, contamination, toxicity, physical and electric damage etc.).
- Whether there might be a need for, or possibility of, discharge into the protected space whilst occupied.
- Whether the system is suitable for protecting unattended processes (out of hours).

4 Suppression system alternatives

In this Section the alternative suppression system options are introduced with reference to other RISCAuthority Automatic Fire Protection Guides (AFPGs) for more detailed specific advice. Selection on the basis of specific design challenges are addressed in Section 5.

4.1 FK-5-1-12 from an alternative source

After 2025 all production of NOVEC™ 1230 by 3M will cease. Alternative providers of FK-5-1-12 are listed in the Significant New Alternatives Policy (SNAP) list and accepted by the US Environmental Agency. 3M warn that manufacturing differences between their established processes and others can cause quality issues that may impact performance and invalidate system certification. Only with the system manufacturer's permission could NOVEC™ 1230 be replaced with FK-5-1-12 from a different manufacturer in a UL Listed or FM Approved system. Please see RISCAuthority AFPG-04 'NOVEC™ 1230' for more detailed system suitability guidance.

NOVEC™ 1230/FK-5-1-12 is characterised by extinguishing fires through cooling. It is a very heavy gas and this needs to be appreciated in the design of the compartment it is to be distributed in, in respect of low-level uncontrolled ventilation paths. As a fluorine containing chemical agent, it breaks down in fire to form hydrogen fluoride which is both highly toxic and corrosive – failure to extinguish for any reason can lead to the generation of very unsafe levels of hydrogen fluoride which can also be highly destructive to sensitive equipment. Its main advantage is one of rapid fire knock down and small agent storage and weight volumes in comparison with inert agents. Raw agent toxicity permits use in occupied spaces, but human exposure (especially during a fire) should be avoided.

4.2 HFC agents

HFC agents, such as FM200 and ECARO will not be considered in this document as viable alternatives to NOVEC™ 1230, being under similar phase out regimes (2030) through the F-gas regulations. Guidance on system suitability can be found in the following RISCAuthority AFPGs:

- AFPG-07 - HFC227ea (aka FM200, FE-227, NAF-227)
- AFPG-08 - HFC125 (aka FE-25, ECARO, R-125 & MH125)
- FE-13 (HFC-23) has been banned under EU guidance since 2016.

The HFC agents are characterised by extinguishing fires through cooling and possibly some chemical inhibition. As fluorine containing chemical agents, they break down in fire to form hydrogen fluoride which is both highly toxic and corrosive – failure to extinguish for any reason can lead to the generation of very unsafe levels of hydrogen fluoride which can also be highly destructive to sensitive equipment. Their main advantage is one of small agent storage and weight volumes in comparison with inert agents. Raw agent toxicity permits use in occupied spaces, but human exposure (especially during a fire) should be avoided.

4.3 Inert gases

Inert gases (excluding carbon dioxide), remain the most environmentally preferential gaseous extinguishing systems that are likely to stand the test of time. Using, in isolation or in combination, gases including argon, nitrogen, and carbon dioxide, these agents work by displacing oxygen from the protected space to a point where combustion can no longer be supported. Guidance on system suitability can be found in the following RISCAuthority AFPGs:

- AFPG-03 - Inergen (aka IG541)
- AFPG-05 - Argonite (aka IG55)
- AFPG-06 - Nitrogen (aka IG100)

The main advantage of inert gases are their robustness of performance (working with the fire to remove oxygen), and not contributing to the toxicity of the fire. For most applications oxygen concentrations post discharge permit use in occupied spaces but human exposure to depressed oxygen atmospheres with mixed fire gases should be avoided. The greatest challenge with the use of inert agents comes from accommodating the system storage and weight requirements, and enclosure ventilation pressure management.

4.4 Carbon dioxide

Carbon dioxide extolls all of the virtues of the aforementioned inert gases with:

- the benefit that, as a liquified gas, it can be accommodated with much less storage space and weight
- the downside that, at extinguishing concentrations, it is extremely toxic.

For these reasons, carbon dioxide use is generally restricted to applications that are space and weight sensitive (such as transport), where strict access control measures ensure human safety, or in compartments that are never occupied, or of a size that are not occupiable (such as cabinets). Carbon dioxide is an extremely effective agent and being a heavy gas may need special venting procedures to ensure its removal post discharge. Guidance on system suitability can be found in the following RISCAuthority AFPG:

- AFPG-09 – Carbon dioxide

4.5 Watermist

The mechanism of fire control for watermist systems is complex but in the best case can be similar to that for inert gas systems, in that generated steam displaces oxygen from the protected compartment, but its ability to do this depends very much on the energy of the fire at the time of application and the amount of ventilation present. As such its key strength is in the management of high energy fires (such as Class B liquid fuel fires) in small compartments where extinguishment may occur, but as compartment sizes increase and the size of fires relatively reduce, their impact may be cyclical, suppressing the fire, but never managing extinguishment. For this reason they should be designed as 'suppression' systems, with other mechanisms in place to alert the need for follow-on actions to ensure the fire is out. Even using small amounts of water can be very beneficial to the mitigation of high temperatures and prevention of flash-over. They are generally safe for actuation in occupied spaces but, like any other system will mix fire gases within the compartment which may impede escape so should be avoided. The general drawback with water-based systems are in the protection of water sensitive assets including electronics.

	FK-5-1-12	Inert gas	Water mist	Sprinklers	Aerosol	CO_2	Dry powder
Designed to extinguish fire	Y	Y	N	N	Y	Y	Y
Leaves no residue (raw agent)	Y	Y	N	N	Y/N	N	N
Electrically non-conductive (raw agent)	Y	Y	N	N	Y	Y	Y
Does not produce HF	N	Y	Y	Y	Y	Y	Y
Suitable for occupied discharge (raw agent)	Y	Y	Y	Y	Y/N	N	Y
Suitable for occupied discharge during fire	NR	NR	Y	Y	NR	N	NR
Ventilation control required	Y	Y	Y	N	Y	Y	Y
Storage requirements	=	>>	>>	>>>	=	>	=
Suitability on Class A fires – Combustible materials	Y	Y	Y	Y	Y	Y	Y
Suitability on Class B fires – Flammable liquids	Y	Y	Y	With foam	Y	Y	Y
Suitability on Class C fires – Flammable gases	N	N	N	N	N	N	Y
Suitability on Class D fires – Combustible metals	N	N	N	N	N	N	Y
Suitability on Electrical fires	Y	Y	N	N	Y	Y	Y
Suitability on Class F fires – Cooking oils	N	N	Y	N	N	N	N

Consideration should be given to the relative recoverability of the protected assets from fire and water damage.

Guidance on system suitability can be found in the following RISCAuthority AFPG:

- AFPG-02 – Watermist

4.6 Sprinkler and drencher systems

Sprinkler systems of the type used for compartment protection use open heads and a centrally operated valve and are termed 'drencher systems'. The dominant fire protection mechanism for large-droplet water systems are fuel removal (making combustible material non-combustible by pre-wetting), and removal of heat from the fire itself. As such they are most effective on Class A solid fuels but can be augmented with firefighting foam to make them effective on Class B liquid fires also. Whilst it might be unlikely that many scenarios arise where they would replace a NOVEC™ 1230 or HFC installation, they are included here for completeness and might be appropriate where the overall fire safety management plan is reconsidered as part of the NOVEC™ 1230/HFC replacement operation.

Guidance on system suitability can be found in the following RISCAuthority AFPG:

- AFPG-14 – Sprinkler and drencher systems

4.7 Dry powder

Pressurised fixed dry powder systems (also known as dry chemical systems) are used in specialist applications where rapid knock down of Class B liquid fuel, and Class C flammable gas fires is required. With application in industrial processes, transport vehicles, marine, and high hazard storage, these compact systems may present a good replacement option for NOVEC™ 1230 (and HFCs) where storage and weight issues have a great impact upon selection. Dry powder extinguishing agents operate by interrupting the combustion chemistry of a fire in a similar way to Halon gas. These systems leave a substantial residue and would not be suitable for environments where contamination of sensitive equipment is to be avoided.

Guidance on system suitability can be found in the following RISCAuthority AFPG:

- AFPG-17 – Fixed dry chemical systems

4.8 Condensed Aerosol Fire Extinguishing Systems (CAFES)

Condensed aerosol fire extinguishing systems are similar to dry powder (chemical) systems in relation to the chemical agents used but the application methods differ. Rather than using a pressurised gas to distribute the powder, CAFES mix the active agent with a combustible solid that, when ignited, issues the powder in a 'smoke-like' form that distributes as gas around the protected space. As compact systems these might find application in NOVEC™ 1230 (and HFC) replacement where space and weight is an issue. Confirmation of suitability for the application would need to be confirmed before adopting this relatively new technology.

Guidance on system suitability can be found in the following RISCAuthority AFPG:

- AFPG-11 – Condensed Aerosol Extinguishing Systems

4.9 Summary

The table on the previous page summarises some of the key attributes of each agent type in comparison to NOVEC™ 1230/HFC agents. In some cases, the answers are slightly subjective because engineering system design may influence suitability of an agents use in any given environment (for example, fixed cooking deep fat fryer installations).

5 Replacement approaches

The replacement of a NOVEC™ 1230 or HFC systems offers the opportunity to re-evaluate the overall fire safety management plan to achieve a better overall balance of safety, environmental relevance, system cost, and efficiency. With no drop in replacement opportunity, aside from the continued use of FK-5-1-12 from an alternative supplier, all options demand an amount of expenditure and reconfiguration of the protected environment to adapt to the strengths of the selected alternative.

5.1 Remove the need for an extinguishing system

A good starting point for any migration undertaking is to assess whether the need for an extinguishing system can be dispensed with altogether. It is not uncommon to find that methods and options have moved on since the original system was installed. A revised method that does not demand the presence of an extinguishing system is by definition a safer approach.

5.2 Re-stock with F-5-1-12 from an alternative source

With full knowledge of the future demise of NOVEC™ 1230 (and HFCs) as viable and allowable fire extinguishing options, the decision whether to change the system or opt for refilling will most likely depend on the envisaged lifespan of the application to which the system is applied, and the overall environmental policy of the organisation.

5.3 Address challenges that would prevent the adoption of an inert agent or CO_2 system

The most highly recommended form of gaseous fire protection system is one of the inert type (and CO_2 where the exposure of personnel is impossible). In this respect it is worth considering whether any challenges that may prohibit its use can be engineered out by alternative means. The principle challenges that may arise include:

- Storage space and weight requirements
- Compartment integrity and pressure strength
- Noise damage to data storage.

In all but a few scenarios (transportation), it is possible to engineer out these challenges. It is recommended that a provider of certificated systems is consulted to see if an inert gas system is appropriate for the specific NOVEC™ 1230 application, and if not, what measures may be taken to make it acceptable. The reward is a system that will never be outlawed on environmental grounds, does not contribute to toxic or corrosive threat, is safe for use in occupied spaces, and is robust in its performance with well-established design criteria.

5.4 Protection requirement (suppression/extinguishment)

Whilst water-based systems differ from the other options in that they are generally designed to suppress a fire rather than extinguish it, their inherent robustness to perform, and legacy benefit even after discharge has ended, can make them preferred systems where high reliability of performance is required. They are particularly good in application where heat removal is important, something that all other mentioned systems are poor at. In applications that are tolerant of water they can be the preferred option to any other type of system. If adopted, the change must be accompanied by a review of how the detection and alarm systems are linked to assure the attendance of Fire Service or local personnel to complete the extinguishing operation.

5.5 Storage space and weight

It is not uncommon for NOVEC™ 1230 to have been selected because of its low size and weight requirement in comparison to inert agent systems.

5.5.1 Where storage space and weight is not an issue

Where storage and weight is not a issue for any candidate replacement system, the user should adopt the system that provides the best fire protection capability, with the highest likelihood of operation, that will cause the lowest amount of consequential damage. The user is advised to read carefully the AFPG for each system in making this determination.

5.5.2 Where storage space and weight are an issue

Where storage space is an issue that cannot be resolved the options to replace NOVEC™ 1230 are limited to:

- Redesigning the application so suppression is not required
- Refilling with FK-5-1-12 for the time being
- Investigating whether CO_2 can fulfil the brief given its inherent toxicity
- Investigating whether a fixed dry powder system is appropriate for the type of risk
- Investigating whether a CAFÉ system is appropriate for the type of risk.

There is also potential for a specialist implementation of another technology, such as watermist. All options should be discussed with an accredited provider of extinguishing systems.

5.6 Ventilation

Most gaseous system installations demand a high degree of enclosure and pressure management to function properly. The compartment must be able to vent overpressure during the discharge period, and seal thereafter to hold the column pressure of the gas at an extinguishing concentration for a period of time appropriate to resolving all sustained ignition sources. In venting potentially toxic agent break down and fire gases during discharge and post-fire, the egress routes must be appropriate so personnel outside the protected space are not exposed. When replacing NOVEC™ 1230 (or an HFC) it is a pertinent time to reconsider the properties of the compartment.

5.7 Good control of compartment ventilation

Where there is good control of the compartment ventilation, any of the replacement options may be chosen.

5.8 Ventilation of compartment is uncontrolled

Where there is little control over the compartment boundaries and the associated ventilation, consideration should be given to water-based systems subject to the water sensitivities of the room's contents. Some ventilation (small amounts) can be accommodated for in the design of gaseous systems by assuming a leakage rate resulting in the use of greater agent quantities, but effort is better managed by improving the enclosure. Carbon dioxide, being a heavy gas, can be applied in streaming agent form into leaky equipment and room for an elongated discharge essentially providing an extinguishing 'plug' of agent for a duration that will extinguish the fire and secure against reignition.

5.9 Dominant fuel types

NOVEC™ 1230 (and HFCs) was principally used in the protection of electrical, electronic, and liquid fuel risks. There is to question its appropriateness for electric and electronic fires given the corrosion potential of hydrogen fluoride gas that would damage sensitive equipment of this type. As such, replacement provides an opportunity to provide an improved response with lower potential consequential damage.

5.9.1 Class A

All replacement options are appropriate to the protection of Class A solid fuel fires. However, the tests used to determine this can be highly stylised and consideration must be given to arrangement geometry and complexity and whether the agent used may access the burning components. Some agents may do this well natively, others will require the adoption of strict installation rules to ensure sufficient application. Solid fuels may also involve geometries that trap air (such as boxes and packaging) that can present a challenge for gaseous systems, and others might involve plastics that can melt to form flowing liquid fires. Water based sprinkler (drencher) systems excel in the management of significant Class A fire risks but where water sensitive items need protecting specialist advice should be sought for complex risks.

5.9.2 Class B

All replacement options are appropriate for the management of Class B flammable liquid fuel fires. Large droplet water system require augmentation with foam additive to be effective (see AFPG-12).

5.9.3 Electrical/electronic fires

Where protection of electrical and electronic fires is the primary aim, refilling of an existing NOVEC™ 1230 from an alternative provider of FK-5-1-12 is not recommended as there is an opportunity to negate the threat to equipment posed by hydrogen fluoride generation. All other options aside from water-based systems are viable, with an obvious preference for inert gas systems as the ones likely to give the highest performance with lowest consequential damage (noise management aside – see 5.10.3).

5.10 Equipment sensitivity

It is important in any protection scenario to have a clear understanding of what is being protected, and the extent of damage that can be accepted within a successful outcome. Fire protection systems may be chosen to protect a piece of equipment, to restrict fire to a compartment, or to save a building. Each option accepts a different amount of consequential damage. NOVEC™ 1230 is used in both equipment and compartment protection scenarios.

5.10.1 Corrosive and conducting by-products of the agent and fire

Consideration of corrosion and agent residue (conducting – such water and powders that might be hygroscopic) usually relates to the protection at an equipment level. To this extent the 'cleanest' agents for equipment protection (electrical) are the inert agents and carbon dioxide. Even with these agents, the fire may also deposit conducting soot which might have corrosive components (hydrochloric acid from PVC insulation) and water vapour which may deleteriously impact equipment. These types of contamination can be greatly reduced by early detection.

5.10.2 Water

Sensitivity to water rules out the use of the water-based systems.

5.10.3 Noise

In the protection of computer suites an incident has been recorded of data loss resulting from the sonic properties of an inert gas discharge. The potential can be ameliorated by the use of specific nozzle designs. Inert gas systems typically require the replacement of 40% of the enclosures volumes with gas in 60 seconds – needless to say it is a fairly robustious discharge.

5.11 Occupation

In relation to occupation, consideration needs to be given to both accidental discharge (no fire – raw agent exposure), and discharge during a fire. Most agents aside from CO_2 and aerosols are designed to not be harmful to life for at least a short period of time. Exposure to carbon dioxide at extinguishing concentrations is immediately life threatening and there is a long history of death resulting from discharge into spaces still occupied by personnel. Aerosol agents can produce significant quantities of carbon monoxide during discharge and deaths have been associated with their discharge in confined spaces although more modern products may not be associated with the same challenge. Either way, in truth, exposure of personnel to all discharges, whether accidental or during fire management should be avoided.

5.11.1 Spaces that will be occupied

Water based systems may be natively appropriate for use in occupied spaces. Inert agents and fixed powder system may have low propensity to cause harm but non-the-less are installed with inter-locked systems to reduce the likelihood of human exposure to discharge with pre-alarm evacuation warning. CO_2 and aerosol systems can be used subject to the rigour of interlocking to ensure human exposure to discharge is impossible, but the use of less toxic options is obviously favoured.

5.11.2 Spaces not normally occupied but could be

All options may be used in this environment subject to the use of appropriate interlocks for when the space is occupied, and the sensitivity of the equipment to the particular agent.

5.11.3 Spaces that cannot be occupied

All agents may be used, but carbon dioxide, a cheap, effective, and compact agent can often be the best system to use in this scenario – spaces that cannot or will never be occupied.

6 Questionnaire

Having established the background challenges to the replacement of NOVEC™ 1230 (and HFCs) with more environmentally friendly options, this questionnaire is designed to assist with eliciting the information required to facilitate the change without compromising performance of the system (and taking every opportunity to improve it).

The questions can be used in association with this guide, and the referenced RISCAuthority AFPGs to determine the best replacement option for the NOVEC™ 1230 or HFC system in question. The questionnaire may be provided to a certificated system provider for consideration.

NOVEC™ 1230/HFC Replacement key data

Current system details	
What class of fire is the system protecting?	Class A ☐ Class B ☐ Class C ☐ Class D ☐ Electrical ☐ Class E ☐
Please give a description of what is being protected.	
Is the equipment or space sensitive to any of the following?	Corrosive gases ☐ Water ☐ Conducting solutions ☐ Solid contaminates ☐ Conduction solids ☐
Please give a description of equipment/compartment sensitivities.	
Will the compartment be occupied?	Yes ☐ Sometimes ☐ Never ☐
Please give more detail to the occupation of the enclosure including regularity.	
How well sealed is the NOVECTM 1230 protected space.	Well-sealed ☐ Leaky ☐ Not sealed ☐ Unknown ☐
Please give more detail on rig sealing and any devices that many exist as part of the NOVEC™ 1230 installation, including a description of the materials of construction of the walls and ceiling.	

	Yes	No
Are there any restrictions on the available space for the system?	☐	☐
Please give specific details of the available space.		
Are there any restrictions on the weight of the system?	☐	☐
Please give specific details of the weight limits.		
Is the current system interconnected to the building's alarm system, and will it summon a response from the Fire Service?	☐	☐
Please give specific details of the detection and alarm system connections.		
Can a suppression system (water-based) be considered as an alternative to an extinguishing system?	☐	☐
Please give specific details of why this option might be pertinent.		