To:	ECHA RAC & SEAC, Dossier Submitters, EU Commission
From:	ExxFire B.V.
Concerns:	ExxFire response to PFAS restriction consultation
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ExxFire response to PFAS restriction consultation

Summary

ExxFire welcomes the proposed restriction of manufacturing, placement on the market, and use of PFAS in clean fire suppressants. However, ExxFire opposes the duration of the proposed 12-year derogation for fire suppression systems using agents based on PFAS with regard to *object protection* - to be distinguished from *room protection*. In accordance with NEN-EN 15004 (Annex A), object protection refers to protection of spaces that are normally unoccupied. Room protection refers to protection of spaces that are intended for occupancy by people.

The proposed 12-year derogation will hamper the technological and commercial expansion of *existing* alternatives based on non-PFAS fire suppression agents such as nitrogen and argon. A 12-year derogation will result in unnecessary PFAS emissions. For object protection, nitrogen and argon inert gas systems fulfil the technical and socio-economic requirements as suitable and available alternative to PFAS-agents.

ExxFire proposes to rephrase the text of the proposed derogation on page 6 of the Annex XV Restriction Report as follows:

> 5. By way of derogation, paragraphs 1 and 2 shall not apply to: …
>
> m^{A}. clean fire suppressing agents *for room protection* where current alternatives damage the assets to be protected or pose a risk to human health until 13.5 years after EiF;
>
> *m^{B}. clean fire suppressing agents for object protection in unoccupied confined spaces until 6.5 years after EiF;*

1. Introduction

In the proposal for the restriction of manufacturing, placement on the market, and use of per- and polyfluoroalkyl substances (PFAS), fire suppressants form a subcategory of applications of fluorinated gases. The restriction proposal contains a proposed derogation for “clean fire suppressing agents where current alternatives damage the assets to be protected or pose a risk to human health until 13.5 years after EiF”. This is motivated by “the sufficiently strong evidence indicating the unavailability of alternatives” and the observation that “current R&D development appears to focus on alternative fluorinated gases, rather than on non-PFAS alternatives”.

In this paper, ExxFire will explain that non-PFAS fire suppressants are in fact available in one particular market segment. Based on technological and socio-economic analysis it will show that, in that particular segment, these technologies fulfil the requirements as a full-fledged alternative. Allowing a 12-year derogation will hamper the technological and commercial expansion of *existing* alternatives and will result in unnecessary PFAS emissions.

To that end, ExxFire will first differentiate the key systems for clean fire suppressants: PFAS-based and inert gas-based. It will then differentiate two very different market segments in which both types of systems can be used: room protection and object protection. Then, ExxFire will outline why for object protection the alternatives to PFAS-based suppressing systems suffice from both a technological and a socio-economic perspective, which is why a five-year derogation period would be sufficient.

2. Types of clean fire suppressing systems

A typical clean fire suppressing system consists of one or more cylinders containing a gas (used to suppress the fire) and an auxiliary system that detects the fire and releases the gas. The term ‘clean’ indicates that the system can extinguish the fire without causing damage to the objects to be protected, unlike aerosols, foam or water (Annex B). In this particular context, the qualification “clean” does not refer to the impact on the environment and health.

For the purpose of this discussion two key clean fire suppressing systems can be differentiated: those that use PFAS-agents and those that use inert gases.

Before explaining more about the two types of fire suppressing systems, ExxFire notes that the vast majority of companies offering clean fire suppressing systems offer both PFAS systems and inert gas systems. As a result, the potential proponents of inert gas systems have an interest in also keeping PFAS systems on the market. This makes it difficult for regulators and other industry players to obtain clear information about the (im)possibilities of restricting certain PFAS systems.

Clean fire suppressing systems based on PFAS (‘PFAS systems’) use different fluorinated gases, as well as blends. An overview of these gases and examples of their trade names is provided in the table below. Based on market analysis (desk research, interviews, own practical experience), ExxFire estimates that roughly one third of all currently installed systems are PFAS systems.

Table 1 – examples of PFAS-systems

Fluorinated gas	Example tradenames
HFC-227ea	FM-200™, MH227®, FE-227™, Solkaflam®227
HFC-125	Ecaro-25®
HK-5-1-12	Novec™1230, Dukare®1230, Noah®5112, MH5112®
HB-55	Solstice®Quench 5

The other type of clean fire suppressing systems uses inert gases (‘inert gas systems’) as an extinguishing agent, such as nitrogen (N_2) and argon (Ar) and their mixtures. We note that the inert gas nitrogen should be distinguished from nitrogen compounds such as nitrogen oxides (e.g., nitrate, ammonia). The latter can be harmful to the environment, whereas inert nitrogen (N_2) forms 78% of the atmosphere. Gaseous CO2 is another type of inert gas used to extinguish (incipient) fires. However, this agent is considered beyond the scope of this paper as it imposes very different environmental, safety and health issues.

ExxFire estimates that nitrogen- and argon-based fire supressing systems already cover approximately half of today’s total market. These inert gas systems are based on the principle of reducing the oxygen concentration by displacement until it reaches a level where combustion is no longer supported, and an (incipient) fire is extinguished. Each system is designed to decrease oxygen to a specific level. When discharged, inert gas is quickly and uniformly distributed within the enclosure.

ExxFire’s system is a special type of inert gas system: a nitrogen generator. Instead of storing the nitrogen in a cylinder under pressure, its sealed steel cylinders contain solid propellant that produces gaseous nitrogen and a solid residue after a chemical reaction (Annex C). The propellant consists of nitrogen containing grain. Its main ingredient is sodium azide (NaN3) (Annex C). The gaseous nitrogen is generated at the moment an incipient fire is detected by smoke detectors, thermal wires or other instruments. After suppressing the fire, the residue inside the system mainly consists of sodium, sand and some auxiliary components.

The gaseous nitrogen is released to displace oxygen and, as a result, suppress the (incipient) fire. All solid products remain inside the casing before, during and after activation. The technology was originally developed by the Netherlands Organisation for Applied Scientific Research (TNO) for the use in satellites (for more information see the ESA website: ESA - Satellietmissie Proba-2 'bijgetankt' met Nederlandse technologie (in Dutch). ExxFire’s technology is certified by the French accredited certification body Centre National de Prévention et de Protection (CNPP) and the US Environmental Protection Agency (EPA) (Annex C; Annex D). Like other inert gas systems, ExxFire systems do not apply or emit any PFAS.

3. Object protection and room protection

The market for fire suppression can be divided in the market for room protection and for object protection. In this context:

- ‘Room protection’ refers to: Protection from fire and fire damage of an enclosed area within a building that is meant for human occupancy.
- ‘Object protection’ refers to: Protection from fire and fire damage of individual items, equipment, material, or assets in confined and normally non-occupied spaces. If a person is temporarily present in a confined space (for example to do mechanical work), safety measures must be in place such as keeping the door open or wearing personal protective equipment, regardless of the fire suppressing system used, as also referred to in the legislation such as article 3.5g of the Dutch *Arbeidsomstandighedenbesluit* (Annex F).

Object projection is and can be used to protect IT servers, battery energy storage systems and other high value equipment. Placing individual objects in confined spaces (such as cabinets) allows a fast and effective response in case the server itself catches fire. This serves to protect the server itself from fire damage, as well as its surroundings.

ExxFire notes that PFAS systems might currently be irreplaceable in (some niches of) room protection. It is important for fire systems engineers to have a well-filled toolbox to ensure a high level of protection against fire and fire damage across the EU. However, ExxFire emphasizes that there are adequate technical and socio-economic inert gas systems for all object protection purposes. This will be explained below.

4. Effective duration of derogation

It has come to ExxFire’s attention that for the scope of the restriction on *use,* the Dossier Submitters intend to differentiate between the use of a *substance* and the use of a *product.* Whereas products containing PFAS would be subject to a phase-out period, substances containing PFAS will not. This distinction can be useful. It is important to note, however, that systems in which substances are put under pressure (such as PFAS-based systems) leak and need to be refilled. Refilling these systems should be regarded as the use of a substance. This would not only be most logical but will also make sense in an effects-based approach. The average life-time of a PFAS-based fire suppressing system is 10 years. If the refilling of fire supressing systems would be allowed, it would effectively extend the derogation period by 10 years, leading to more unnecessary PFAS-emissions.

It is ExxFire’s view that a five-year derogation could be necessary to let the market for object protection adjust to the new reality. ExxFire estimates that roughly half of the market for room- and object protection is already served by nitrogen and argon inert gas-based fire supressing systems. This means that a 12-year derogation can unnecessarily delay the transition and lead to unnecessary PFAS emissions. Especially so, since most suppliers of fire supressing systems offer both PFAS- and inert gas based systems.

5. Technical analysis of non-PFAS alternatives

Contrary to the preliminary comments in the restriction proposal, inert gas systems have technical equivalence vis-à-vis PFAS systems for object projection. This will be explained below based on five metrics: to what extent the inert gas systems are effective, fast-acting, safe, clean, and green.

<u>5a. Effective / similar performance</u>

Inert gases serve as highly effective fire suppression gases due to their inherent properties. Inert gas systems for object protection, including ExxFire systems, have an almost identical performance in suppressing fire to PFAS systems, as confirmed by EPA (Annex E, p. 113-117). Arguably, inert gas systems are better suited for object protection, because PFAS systems show condensation in small spaces, resulting in less efficient mixing, and making them less effective.

Performance of both PFAS systems and inert gas systems is largely based on the quality and maintenance of the auxiliary elements of the systems, such as the detectors, piping and initiators.

5b. Fast-acting

It is crucial that fire suppressing systems can act quickly in order to rapidly extinguish (incipient) fires, thereby minimising potential damage to property and human lives. For object protection, PFAS systems and inert gas systems can detect and suppress fires with equal speed within the release time mentioned by extinguishing regulations (Annex A, Gi, and Gii).

It is noted that for *room* projection, some inert gases (mainly carbon dioxide) require some time between detection of the fire and discharge of the gas to allow people to leave the room. This deliberately built-in discharge time typically amounts to 30 seconds. In case of *object* protection (where no people are present) introducing such discharge times is not necessary.

5c. Safe

5c.1 Toxicity

The reason for restricting the use of PFAS systems as soon as possible is their hazardous characteristics. For example, FK-5-1-12 is known to be converted in the atmosphere by a photolytic pathway. End products include hydrogen fluoride (HF) and trifluoroacetic acid (TFA) (Annex H and Annex I (see B.4.2.7.3). TFA is a persistent and mobile pollutant. Its multiple adverse effects (Annex I (see B.5.1.2.5-B.2.2.3)) warrant restrictions on any source, including FK-5-1-12.

During the lifetime of a PFAS system of typically 10 years, approximately 17 - 27% of the PFAS gases will be released into the environment – since each year approximately 2 to 3% of the installed capacity is used to suppress a fire, for a false alarm or for testing. Additionally, all PFAS systems experience leakage of PFAS gases throughout their lifecycle. As long as PFAS systems are installed, PFAS emissions will continue. The environmental impact will be significant.

The most commonly used gas in PFAS systems is FK-5-1-12, for which the patent has expired in 2020. Already we are seeing new ‘generic’ producers entering the market, mainly from Asia. This makes it harder to keep control of the exact composition and purity of the PFAS gases entering the EU market. Harmful contaminations, including PFAS other than FK-5-1-12, are known to be present and aggravate PBT concerns.

Nitrogen and argon as inert gases are not toxic.

It is noted that the use of nitrogen as a fire suppressant can reduce oxygen levels to 10-12 percent, which can cause a potential asphyxiation hazard. However, this is only relevant in the case of *room protection* since object protection by definition assumes absence of people.

Inert gas systems using nitrogen generators use cylinders containing sodium azide. Upon detection of fire this substance is used to create the nitrogen gas. Sodium azide is a toxic chemical. Hence, during the production phase workers are protected from exposure. Throughout the use phase of the system the substance remains inside the metal cylinder protected by the filter design (Annex C). As such there is no risk of exposure to users.

After extinguishing a fire with a cool gas generator, about 2.5 kg reaction residue per kg nitrogen remains within the cylinder. This residue consists of byproducts, a filter and a liner (inner tube). The reaction residue is not expected to result in adverse health effects due to the small amounts (Annex E, p. 114). Moreover, the design of the generators prevents any uncontrolled release of the reaction residue.

Indeed, EPA evaluated the occupational and general population exposure of ExxFire systems specifically. It concluded that production and use of its nitrogen generators systems will not pose unacceptable risks to workers or the general public (Annex E, p. 114-115). All used cool gas cylinders are returned to ExxFire to ensure proper processing. The residue that remains is pyrophore but can easily be processed as chemical waste. The residue consists of sodium (Na), iron oxide (Fe_2O_3), potassium silicate (K_2SiO_3) and lithium fluoride (LiF). Sodium will soon be converted to sodium oxide (Na_2O) and sodium hydroxide (NaOH). All other components are inert. ExxFire reuses all chemical residues where possible, and the remaining residues are processed via high temperature incineration by a qualified waste processor.

As such, limiting PFAS systems for object protection would *not* result in regrettable substitution.

5c.2 Safe handling
Only on the aspect of safe handling, PFAS systems normally stand out beneficially compared to *pressurized* inert gas systems. PFAS systems are usually stored in their containers at 52 bar (Annex J), while typical inert gas systems require a pressure of 200-280 bar. Compressed gases can pose a risk of rupture or even explosion, in particular during transport and installation. The higher the pressure, the larger the risk of rupture or explosion. This can cause harm to anyone nearby or damage to equipment. Similarly, if a component (for example a valve) fails, it may release fragments or debris at high velocity, which can cause injury or damage.

However, inert gas systems using nitrogen generators (such as ExxFire generators) provide a solution. Since such generators do not contain any compressed gas, they do not carry a risk of sudden rupture. After detecting a fire, nitrogen generators create in-cylinder pressure up to a relatively low 20 – 30 bars which is then immediately used to suppress the fire.

5d. Clean

Alternatives to PFAS systems must be ‘clean’, meaning they should be appropriate for water-sensitive equipment and not leave residues on the object to be protected (as would be the case with aerosol extinguishers, for example). Just like PFAS systems, inert gas systems suppress (incipient) fire by lowering the oxygen level. The nitrogen system increases the level of naturally present nitrogen without creating residues. As such, inert gas systems are clean.

5e. Green

ExxFire finds it important to note that the use of inert gas systems based on nitrogen and argon do *not* contribute to ozone layer depletion or to global warming (Annex E, p. 115). Illustratively, ExxFire was awarded the Solar Impulse Efficient Solution Label in 2021 (Annex K). Inert gas systems using nitrogen generators are accepted by the EPA as a green agent (Annex E, p. 113-117).

Inert gases also have the advantage of not reacting to other substances, meaning negative impact on the environment is minimized while not sacrificing performance.

6. Socio-economic aspects of non-PFAS alternatives

6a. Availability

As stated above and based on deep knowledge of the market, ExxFire estimates that in general, nitrogen and argon inert gas systems already cater to roughly half of the clean fire suppressant market for both room and object protection. Inert gas systems are based on proven technology and do not use rare materials. There is no reason why the production of the inert gas and the required materials would not be able to meet any additional demand after the restriction of PFAS systems for object protection.

After the end of the derogation period, part of the objects currently protected by PFAS systems will be protected by inert gas systems using nitrogen generators. These generators are based on a relatively new technology. While the technology is proven and certified, current production capacity is still quite limited. So far, 2,300 ExxFire-systems have been installed, with sales and market acceptance rising after its system became CNPP-certified. See Annex M for an example of an ExxFire-cooperation.

Granting a 12-year derogation for PFAS systems, however, would constitute a self-fulfilling prophecy because it would inhibit innovation and market development. A 5-year derogation would be suitable to adapt.

6b. User-friendly

PFAS systems as well as inert gas systems come in many shapes and forms, although these differences are mainly relevant for the larger systems used for room protection. For object protection, differences are relatively small.

Inert gas systems using nitrogen generators can be placed as close to the object to be protected as demanded by the customer or situation. They can be mounted on the wall and fit in small spaces like cabinets (Annex N, p. 19). There is no requirement to place them in a special location in a building, such as in the basement or close to a window. This flexibility makes it hard to think of a situation for object protection where an inert gas system (using nitrogen generators or otherwise) would not be able to replace a PFAS system.

6c. Affordability

Previous research has shown that the total cost of ownership (TCO) is similar for PFAS systems and inert gas systems (both traditional inert gas systems and those based on nitrogen generators) (Annex N, p. 9). Annex O shows the current cost-comparison estimation for an object of 5 m^3.

Inert gas systems using nitrogen generators have a higher purchase cost of approximately 11%, but their engineering and maintenance cost is almost 50% lower. Furthermore, the total cost of ownership is between 11 and 30% lower for ExxFire fire supressing systems. This is due to maintenance cost being 45% lower in total over a lifespan of 10 years.

The total cost of ownership for ExxFire systems is lower than for current PFAS-systems.

6d. Cost of substitution

For most existing PFAS systems used for object protection, drop-in of an alternative non-PFAS gas is unlikely to be an option. This means there will be cost of substitution. However, during the transition- and derogation period there will be non-prohibition-related causes for substitution as well. Additionally, replacing PFAS-systems with inert gas systems will in most cases result in lower maintenance costs and a more reliable fire suppressing system. These dynamics will significantly lower the total cost of substitution specifically linked to the prohibition, as further substantiated below.

6d.1 End-of-life substitution and use-substitution

It is important to keep in mind that next to the substitution instigated by the PFAS-prohibition, there will be two other types of substitution during the transition- and derogation phase. These are: 1) the end-of-life substitution and 2) use-substitution. The following estimation presumes that the prohibition becomes effective 6.5 years after EiF.

- *End-of-life substitution:* with an estimated lifetime of 10 years, certain PFAS-systems will need to be replaced during the transition- and derogation phase. 10 years after EiF all PFAS-systems installed at the time of EiF will need to be replaced anyway. We assume a linear trajectory. After the EiF of the prohibition, it makes economic sense to replace PFAS systems with non-PFAS systems.

- *Use-substitution*: in addition to end-of-life substitution, each year approximately 2 - 3% of the installed systems need replacement because it was used to suppress a fire, for a false alarm or for testing.

If we subtract the systems replaced due to end-of-life substitution and use-substitution, the number of PFAS-systems that need to be replaced due to the prohibition (so when the prohibition becomes effective 6.5 years after EiF) is 24 - 27% of PFAS-systems that were installed at the time of EiF.

6d.2 Foregoing maintenance costs
Additionally, PFAS systems for object protection have a lifetime of 10 years, after which the cartridge needs to be replaced. PFAS systems are pressurized, meaning they will need to adhere to the maintenance requirements of the Pressurized Equipment Directive (PED). As shown in Annex O, this is a costly procedure which involves emptying all cylinders and hydrostatically testing them for pressure. Additionally, PFAS systems are known to leak, requiring them to undergo yearly maintenance and refilling.

Unlike other fire suppressing options, inert gas systems using nitrogen generators do not require hydrostatic tests, eliminating lifecycle expenses every 10 years (Annex N, p. 19). Where a 10-year refurbishment is estimated to cost about 20% of the original system cost, nitrogen generators are returned to manufacturers for maintenance at the end of their service life. The associated costs would be 10% of the initial system costs, which result in lower lifecycle costs (Annex N, p. 6).

Concluding that a 5-year derogation period, including 18 months implementation period, means that 27% of the currently installed systems would have to be replaced before the end of their 'natural' depreciation time or their major maintenance. This leads to replacement costs for 27% of remaining systems. These costs will partially be offset by the fact that maintenance of PFAS-free alternatives is significantly lower in cost and manpower. Given the negative impact of PFAS gases we believe the early substitution of a part of existing PFAS system is necessary and proportionate.

Concluding remarks

The proposed 12-year derogation for fire suppression agents is unnecessarily long and should be revised to five years. A transition period of five years is not only desirable but also feasible, since alternatives to fluorinated gases as fire suppressing agents are already available.

A prolonged derogation of twelve years, in contrast threatens to impede the transition towards PFAS-free fire suppression agents. A derogation of five years for fire suppressing systems for *object protection* is expected to be sufficient to allow for a full and functional transition to non-PFAS based systems.

Therefore, ExxFire proposes to rephrase the text of the proposed derogation on page 6 of the Annex XV Restriction Report as follows:

'5. By way of derogation, paragraphs 1 and 2 shall not apply to: …
mA. clean fire suppressing agents for room protection where current alternatives damage the assets to be protected or pose a risk to human health until 13.5 years after EiF;
mB. clean fire suppressing agents for object protection in unoccupied confined spaces until 6.5 years after EiF.'