Agency Opinion on the Annex 15 Report on the Proposal for a Restriction

Per- and polyfluoroalkyl substances (PFAS) in firefighting foams

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Contents

1 Basis for the proposal

Per- and polyfluoroalkyl substances (PFAS) are a broad class of synthetic, fluorinated organic chemicals. They have attracted regulatory attention globally owing to their pervasiveness and persistence in the environment which make them difficult to remove using current remediation methods. Firefighting foams (FFF) that contain PFAS are a source of direct emissions of these substances into the environment.

On 05 March 2024, the Secretary of State for the Department for Environment, Food and Rural Affairs (Defra), with the agreement of the Scottish Government and the Welsh Government, asked the Health and Safety Executive (HSE)[1], as the Agency for UK REACH, to prepare an Annex 15 report in respect of a possible restriction on PFAS in firefighting foams (FFF).

On 18 August 2025, the Agency published an Annex 15 report which provided an assessment of the human health and environmental risks associated with the use of PFAS in FFF. It assessed the alternatives to PFAS, along with the effectiveness, practicality, monitorability and economic impacts of potential risk management measures. This concluded that the use of PFAS in FFF presents a risk to the environment, and human health via the environment, that is not adequately controlled by measures already in place and suggested that a restriction under UK REACH on the placing on the market and use of FFF containing PFAS was an appropriate measure to reduce the identified risk. The Annex 15 report was published on 18 August 2025, with interested parties invited to comment by 18 February 2026.

This document presents the opinion of the Agency on options for a restriction on PFAS in FFF. A summary of the justification for the restriction options is provided in this document, with the full rationale and further supporting information provided in the Background Document (HSE, 2026). The Background Document updates the earlier Annex 15 report (published in August 2025; (HSE, 2025)) to account for information received during the consultation period and other relevant information resulting from the opinion-making process.

Further information on the process for adoption of this opinion is provided in Annex 1 to this document.

[1]The Health and Safety Executive (HSE) acting in its capacity as the Agency for UK REACH, and with support from the Environment Agency in accordance with Article 2B of UK REACH.

2 Opinion of the Agency

2.1 Agency opinion: risk assessment

The Agency's opinion as to whether the restriction options are appropriate in reducing the risk to human health and/or the environment was formulated in accordance with Article 70 of UK REACH on **11 June 2026**.

The Agency has formulated its opinion on the restriction options based on an evaluation of information related to the identified risk and the identified options to reduce the risk as documented in the Annex 15 report, published in August 2025 (HSE, 2025) and Section 3 of this Opinion. The Agency has also taken account of information obtained from interested parties following publication of the Annex 15 report (HSE, 2025) and the recommendations of the REACH Independent Scientific Expert Pool (RISEP).

The Agency is of the opinion that a restriction on the placing on the market and use of PFAS in FFF in Great Britain (GB) is an appropriate measure to reduce the identified risks to human health and the environment.

2.2 Agency opinion: socio-economic analysis

The Agency has prepared its draft opinion on the restriction options and their socio-economic impact. In preparing this draft opinion, the Agency has taken account of the information received from interested parties following publication of the Annex 15 report, the recommendations from RISEP and the opinion on the risk assessment.

The Agency is of the opinion that a restriction under UK REACH on the placing on the market and use of PFAS in FFF in GB is an appropriate measure to reduce the identified risks to human health and the environment, when considering the proportionality of its socio-economic benefits to its socioeconomic costs.

Options for a restriction under REACH are presented in Section 3 of this Opinion. These options are analysed against criteria of effectiveness, practicality and monitorability (as required under Annex 15 of UK REACH). A summary of the information used to support the conclusions reached is provided in Section 4 of this Opinion, with full details in the Background Document.

Interested parties are invited to provide their comments on the draft opinion on the socioeconomic analysis no later than 60-days from the date of publication of this document.

3 Proposed restriction

3.1 Summary of opinion

The Agency concludes that the use of PFAS in FFF presents a risk to the environment, and human health via the environment, that is not adequately controlled by measures already in place. This is due to:

- The very persistent and mobile nature of the PFAS terminal degradation products resulting from the use of these foams, which can lead to contamination of water sources, including those used for drinking water.
- The potential for these substances to remain in the human body for a long time following exposure, with continued exposure expected to lead to their increasing levels in the body at any given time (that is, increasing body burdens). Some terminal degradation products are suspected carcinogens. Various terminal degradation products and other PFAS have resulted in a range of adverse effects in experimental studies in laboratory animals, and some have been reported to cause harm to the developing child and adverse effects in organs such as the liver or to the immune system in humans.
- Evidence of emissions of PFAS to the GB environment from this use (c.a., 50 tonnes of direct emissions estimated per year).
- The inability of existing measures to adequately control the emission of PFAS into the environment from the use of FFF or ensure the appropriate management of PFAS FFF at the end of use.
- The difficulty in remediating contamination from these substances, meaning continued emissions from the use of FFF are expected to lead to progressively increasing concentrations of PFAS in the environment over time, contributing to PFAS exposures in the population.

The Agency considers that alternatives are broadly available to replace PFAS in FFF across all sectors, although acknowledges that challenges for transition remain in certain areas, particularly in the petrochemical industry and at offshore oil and gas installations.

Therefore, the Agency concludes that a restriction on the placing on the market and use of PFAS-containing firefighting foams, with sector or use specific transition periods, is appropriate to reduce the identified risks to the environment and human health via the environment in a proportionate way.

As some of the proposed transition periods are 5 years or longer (refer to Table 1 below), the Agency concludes that measures should be in place to minimise the impact of emissions of PFAS into the environment resulting from the remaining uses during this time.

The Agency also acknowledges that emissions can result from the handling of waste stemming from the use of PFAS-containing foams (including wastewater) during this time and also from remaining stocks of PFAS-containing foam that have not been used to fight a fire. As acknowledged in Section 2 of the Government's PFAS plan (Defra, 2026), specific environmental/waste legislation and permitting to control PFAS is in place outside of UK REACH, and these provisions could be further clarified or strengthened to address this issue.

However, the Agency has considered that the decision maker[2] may choose to address the emissions from these sources within this restriction. This could help ensure that any stocks of foam no longer required and waste generated as a consequence of this restriction (e.g. firewater, rinsate, PPE) or from continued use of foams during the longer transition periods (of 5 years or more) are handled in a consistent manner. This would replicate the approach taken in the European Union (EU) REACH restriction of PFAS in FFF. The restriction options and further explanation below provide the decision maker with information about potential restrictions that could be put in place, and are assessed against the criteria of effectiveness, practicality and monitorability (as required under Annex 15 of UK REACH), including whether the restrictions are proportionate and cost-effective.

3.1.1 Suggested restriction options:

The text below has been drafted to describe the **proposals of the Agency outlined in this Opinion** with regard to suggested restrictions and is therefore illustrative of this intent. **This is not intended as the final text for any Annex 17 entry,** because that is the role of the decision maker.

These options have been drafted following the Annex 15 public consultation, whereby the Agency stated that additional complementary measures that could minimise emissions would be considered during the opinion development stage. These options include additional measures from the proposal in the Annex 15 dossier.

The difference between the options is how the emissions from unused stock and waste are addressed, with RO2a and RO2b providing for the handling of certain aspects of waste via the restriction.

For the purpose of the proposed restriction options, the following definitions apply:

- "*Firefighting foams*" means any mixtures to fight fires with foam and includes but is not limited to firefighting foam concentrates and firefighting foam solutions to produce the foam.

[2] The Secretary of State is the decision maker, subject to the consent requirements in Article 4A of UK REACH regarding Scottish and Welsh Ministers.

- "*Unused stock of foam*" means firefighting foams which have not yet been used to fight fires. This includes foam held within firefighting systems or equipment that has not yet been deployed.
- "*Portable fire extinguisher*" means a fire extinguisher designed to be carried and operated by hand which in working order has a mass of not more than 20 kg, in accordance with the standard EN3-7; a mobile extinguisher of not more than 150 litres, in accordance with the standard EN-1866; and a spray can extinguisher in accordance with the standard EN-16856.
- *"Irreversibly transformed/destroyed*" means the PFAS content has been broken down or converted so that it no longer meets the definition of PFAS and cannot revert back to PFAS or generate PFAS in the environment.
- "*PFAS*" means any substance that contains at least one fully fluorinated methyl (CF_3) or methylene (CF_2) carbon atom (without any hydrogen, chlorine, bromine, or iodine atom attached to it).

Restriction Option 1 (RO1):

A restriction on the placing on the market and use of PFAS in firefighting foam in a concentration equal to or greater than 1mg/L for total organic fluorine from PFAS with:

1. Sector specific transition periods for placing on the market and use (see Table 1 below).
2. If the transition period for use within that sector is 5 years or over (except for portable fire extinguishers), then from a year after any restriction enters into force, the users of such firefighting foams must:
    - 2.1. Ensure PFAS-containing foams are only used for fires involving flammable liquids (Class B fires).
    - 2.2. Reduce emissions to environmental compartments and direct and indirect human exposure to PFAS-containing foams to as low a level as is reasonably practicable.
    - 2.3. Establish a "PFAS-containing firefighting foams management plan" specific for the place of use, which will be reviewed at least annually and made available on request to an enforcing authority (for a period of 15 years), which includes:
        - 2.3.1. The use conditions and volumes of PFAS-containing foams on site,

2.3.2. How emissions to the environment from the use of PFAS-containing foams and direct and indirect human exposure to these foams are reduced (as per point 2.2),

2.3.3. Details on the type and methods of cleaning and maintenance of equipment,

2.3.4. Plans to be implemented in the event of accidental leakage/spillage of firefighting foam including the documentation of any relevant follow-up actions,

2.3.5. A strategy for substituting PFAS-containing foams with suitable fluorine free alternatives.

3. Once considered as waste, any foams or associated waste products from use of PFAS-containing foam should be handled in accordance with measures prescribed by the relevant enforcing authority.

4. From a year after entry into force, firefighting foams in which the concentration is equal to or greater than 1mg/L for total organic fluorine from PFAS that are placed on the market (excluding portable fire extinguishers) must be labelled. This label must read “WARNING: Contains per- and polyfluoroalkyl substances (PFAS) with a concentration equal to or greater than 1 mg/L for the sum of all PFAS”. This information must be visibly, legibly and indelibly marked.

5. Evidence to demonstrate action has been taken to transition to suitable fluorine free alternatives must be kept in line with point 2.3 above. In the absence of sufficient information, and by way of a derogation from point 1, the Agency considers a threshold of 50mg/L of total organic fluorine from PFAS in foams originating from previously contaminated equipment (excluding portable/mobile fire extinguishers) to be appropriate for enforcement purposes.

Under RO1, once considered as waste, any PFAS-containing foams or associated waste products from use should be handled in accordance with measures prescribed by the relevant enforcing authority and under the specific legislation that covers waste and/or permitting. This is in line with how waste is handled for other REACH restrictions. However, it is acknowledged (see Sections 3.1.9.1 and 3.1.9.2 of the Background Document) that the current framework may not facilitate the clear handling and disposal of unused stocks of PFAS-containing foams and/or waste from this restriction, and that there could be clarification and strengthening of these more appropriate legal provisions to address this. Therefore, the decision maker could choose to include measures under REACH to ensure that any stocks of unused PFAS-containing foams and also any waste from use of those foams and from transition to fluorine-free foam associated with the implementation of any restriction, are collected and adequately handled for treatment to minimise emissions. The Agency therefore presents options (**RO2a and RO2b**) for the

decision-maker when they are conducting their assessment of unacceptability of risk from PFAS in FFF. These options differ from RO1 in that they include explicit provisions in the REACH restriction itself for:

i) the collection for adequate treatment of unused PFAS-containing FFF stocks (RO2a and RO2b).
ii) the additional (and separate) collection and adequate treatment of PFAS-containing waste, including wastewater, which originates from use of the foams (RO2b).

Restriction Option 2a (RO2a):

A restriction on the placing on the market and use of PFAS in firefighting foam in a concentration equal to or greater than 1mg/L for total organic fluorine from PFAS with:

1. Sector specific transition periods for placing on the market and use (see Table 1 below).
2. If the transition period for use within that sector is 5 years or over (except for portable fire extinguishers), then from a year after any restriction enters into force, the user of such firefighting foams must:
    2.1. Ensure PFAS-containing foams are only used for fires involving flammable liquids (Class B fires),
    2.2. Reduce emissions to environmental compartments and direct and indirect human exposure to PFAS-containing foams to as low a level as is reasonably practicable,
    2.3. Ensure the collection of unused stock of firefighting foam and ensure their handling for adequate treatment in such a way that the PFAS content is destroyed or irreversibly transformed,
    2.4. Establish a “PFAS-containing firefighting foams management plan” specific for the place of use, which will be reviewed at least annually and made available on request to an enforcing authority (for a period of 15 years), which includes:
        2.4.1. The use conditions and volumes of PFAS-containing foams on site,
        2.4.2. How emissions to the environment from the use of PFAS-containing foams and direct and indirect human exposure to these foams are reduced (as per point 2.2),
        2.4.3. Information on the collection and adequate treatment (as per point 2.3)
        2.4.4. Details on the type and methods of cleaning and maintenance of equipment,

2.4.5. Plans to be implemented in the event of accidental leakage/spillage of firefighting foam including the documentation of any relevant follow-up actions,

2.4.6. A strategy for substituting PFAS-containing foams with suitable fluorine free alternatives.

3. Once considered as waste, and subject to the arrangement above for unused stocks of PFAS-containing foams, associated waste products from use should be handled in accordance with measures prescribed by the relevant enforcing authority.

4. From a year after entry into force, firefighting foams in which the concentration is equal to or greater than 1mg/L for total organic fluorine from PFAS, that are placed on the market (excluding portable fire extinguishers) must be labelled. This label must read “WARNING: Contains per- and polyfluoroalkyl substances (PFAS) with a concentration equal to or greater than 1 mg/L for the sum of all PFAS”. This information must be visibly, legibly and indelibly marked.

5. From a year after entry into force, unused stocks of PFAS-containing firefighting foams (as per point 2.3 above) in which the concentration is equal to or greater than 1mg/L for total organic fluorine from PFAS, must be labelled. This label must read “WARNING: Contains per- and polyfluoroalkyl substances (PFAS) with a concentration equal to or greater than 1 mg/L for the sum of all PFAS”. This information must be visibly, legibly and indelibly marked**.**

6. Evidence to demonstrate action has been taken to transition to suitable fluorine free alternatives must be kept in line with point 2.4 above. In the absence of sufficient information, and by way of a derogation from point 1, the Agency considers a threshold of 50mg/L of total organic fluorine from PFAS in foams originating from previously contaminated equipment (excluding portable fire extinguishers) to be appropriate for enforcement purposes.

Restriction Option 2b:

A restriction on the placing on the market and use of PFAS in firefighting foam in a concentration equal to or greater than 1mg/L for total organic fluorine from PFAS with:

1. Sector specific transition periods for placing on the market and use (see Table 1 below).

2. If the transition period for use within that sector is 5 years or over (except for portable and fire extinguishers), then from a year after any restriction enters into force, the users of such firefighting foams must:

   2.1. Ensure PFAS-containing foams are only used for fires involving flammable liquids (Class B fires),

2.2. Reduce emissions to environmental compartments and direct and indirect human exposure to PFAS-containing foams to as low a level as is reasonably practicable,

2.3. Ensure that unused stocks of PFAS-containing foam and PFAS-containing waste originating from the use of firefighting foams (including wastewater) are collected separately where technically and practically possible – and ensure their handling for adequate treatment in such a way that the PFAS content is destroyed or irreversibly transformed.

2.4. Establish a "PFAS-containing firefighting foams management plan" specific for the place of use, which will be reviewed at least annually and made available on request to an enforcing authority (for a period of 15 years), which includes:

2.4.1. The use conditions and volumes of PFAS-containing foams on site

2.4.2. How emissions to the environment from the use of PFAS-containing foams and direct and indirect human exposure to foams are reduced (as per point 2.2),

2.4.3. Information on the collection and adequate treatment (as per point 2.3)

2.4.4. Details on the type and methods of cleaning and maintenance of equipment,

2.4.5. Plans to be implemented in the event of accidental leakage/spillage of firefighting foam including the documentation of any relevant follow-up actions,

2.4.6. A strategy for substituting PFAS-containing foams with suitable fluorine-free alternatives.

3. From a year after entry into force, firefighting foams in which the concentration is equal or greater than 1mg/L for total organic fluorine from PFAS that are placed on the market (excluding portable fire extinguishers) must be labelled. This label must read "WARNING: Contains per- and polyfluoroalkyl substances (PFAS) with a concentration equal to or greater than 1 mg/L for the sum of all PFAS". This information must be visibly, legibly and indelibly marked.

4. From a year after entry into force, unused stocks of PFAS-containing foams and PFAS-containing waste, including wastewater, originating from the use of firefighting foams (as per point 2.3 above) in which the concentration is equal or greater than 1mg/L for total organic fluorine from PFAS, must be labelled. This label must read "WARNING: Contains per- and polyfluoroalkyl substances (PFAS) with a concentration equal to or greater than 1 mg/L for the sum of all PFAS". This information must be visibly, legibly and indelibly marked.

5. Evidence to demonstrate action has been taken to transition to suitable fluorine free alternatives must be kept in line with point 2.4 above. In the absence of sufficient information, and by way of a derogation from point 1, the Agency considers a threshold of 50mg/L of total organic fluorine from PFAS in foams originating from previously contaminated equipment (excluding portable fire extinguishers) to be appropriate for enforcement purposes.

To aid the decision maker in their consideration of unacceptable risk, all options have been further analysed against the criteria of effectiveness, practicality and monitorability – as well as their cost-effectiveness. All options are considered to meet these criteria, albeit to differing extents. Further information is provided in Sections 4.3.4 – 4.3.7 of this Opinion and in Section 6 of the Background Document.

The proposed transition periods that are applicable to all options are provided in Table 1 below. The proposed periods are intended to support an orderly transition and ensure that users can adapt to suitable alternatives without jeopardising safety. These periods have been determined using those derived in the EU restriction of PFAS in FFF as a foundation and supplemented with GB specific information obtained during the development of this proposal. Additional information to support the proposed transition periods is included in the socioeconomic assessment.

NB. The EU restriction entered into force on 23 October 2025. As such, transition to fluorine free foams (F3) is expected to be underway for EU-based stakeholders. Depending on when any GB restriction enters into force, the EU transition periods for certain uses or sectors will have already concluded or be close to concluding (e.g., for the placing on the market of portable fire extinguishers). Whilst transition in the EU is likely to affect the overall availability of F3, the Agency does not have any information on how this will impact transition in GB given the lack of legislative certainty to drive investment into transition. These factors should be taken into account by the decision maker if they choose to change any of the suggested transition periods.

Table 1: Proposed transition periods

	Sector/use	UK		EU	
		Placing on the market	Use	Placing on the market	Use
1	Portable fire extinguishers (defined by BS EN3-7, BS EN-1866 and BS EN-16856)	6 months	5 years	1 year (or 18 months for alcohol resistant foams)	5 years
2	COMAH[a] sites; except for those already covered by the arrangements for aviation (see point 6)	10 years	10 years	10 years	10 years
3	Training and testing[b]; except testing of firefighting systems for their function	18 months	18 months	18 months	18 months
4	Fire and rescue services (FRS); except those also responsible for attending industrial fires for establishments covered by COMAH, where the 10 year transition period will apply for **use at these establishments only** (see point 2)	18 months	18 months	18 months	18 months
5	On board civilian vessels[c] where FFF has been placed on board before entry into force	10 years	10 years	10 years (for ships with FFF placed on board before 23 October 2025)	10 years (for ships with FFF placed on board before 23 October 2025)
6	Civilian aviation sites	5 years	5 years	5 years	5 years

7	Defence[d]; except for military vessels where a 10 year transition period will be applicable	5 years	5 years	5 years (and 10 years for military vessels)	5 years (and10 years military vessels)
8	Offshore oil and gas installations	10 years	10 years	10 years	10 years
9	All other uses[e]	5 years	5 years	5 years	5 years

[a]Where COMAH refers to the Control of Major Accident Hazards (COMAH) Regulations 2015.

[b]A separate transition period is considered appropriate for training with FFF compared to their use during live incidents. Given most training takes place under controlled conditions and measures are already in place to use PFAS-free foams for such purposes, a relatively short transition period is considered appropriate. Likewise for testing (e.g. testing foams to establish suitability), a shorter transition period is considered appropriate. An exception should be made for the testing of fixed firefighting systems to ensure they can continue to comply with required safety standards until the end of the sector-specific transition periods.

[c] Civilian vessel means all non-military waterborne craft, including sea-going vessels and inland-waterway craft.

[d]Defence is considered to include sites on land either owned by the Ministry of Defence (MoD), or where the MoD has rights to the land or assets owned by or operated on behalf of the MoD. An exception should be made for use on military vessels, where a longer transition period is considered appropriate to account for specific defence requirements and to allow for any refitting.

[e]There may be other uses that are not covered by the sector specific transition periods in points 1 to 8. For such cases, the Agency suggests a 5 year transition period which is in line with the requirements for most sectors. Other uses could, for example, include chemical manufacturing facilities not classed as COMAH sites.

3.1.2 Restriction Intent

The following section provides further information to support the suggested restriction options.

3.1.2.1 Definition of PFAS and scope

For the purpose of the restriction, the Agency considers that PFAS should be defined as ***"any substance that contains at least one fully fluorinated methyl (CF_3) or methylene (CF_2) carbon atom (without any hydrogen, chlorine, bromine, or iodine atom attached to it)".***

This is consistent with the definition used by the Organisation for Economic Co-operation and Development (OECD).

The exact composition of the PFAS contained in firefighting foams is largely unknown because of the proprietary nature of the products and because PFAS manufacturing processes can result in complex mixtures of structurally related PFAS. It is also possible that PFAS not currently used in FFF could be developed as alternatives or for new applications. Therefore, aligning the definition of PFAS for the proposed restriction with the OECD definition of PFAS to encompass the whole PFAS class reduces the potential for substitution with other PFAS that have the same risks as those already identified and has practical benefits that support implementability, enforceability and monitorability.

The Agency notes that the following PFAS are already subject to other provisions that address the identified risk:

(a) perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF), perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds and perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds, covered by Annex I to The UN Stockholm Convention on Persistent Organic Pollutants (POPs) (implemented in GB by the assimilated EU Regulation 2019/102123, as amended by The Persistent Organic Pollutants (Amendment) (EU Exit) Regulations 2020/1358);

(b) long-chain perfluorocarboxylic acids, their salts and related compounds (linear and branched perfluorocarboxylic acids of the formula CnF2n +1-C(= O)OH where n = 8 to 20 (C9-C21 PFCAs) including their salts, covered by Annex I to The UN Stockholm Convention on Persistent Organic Pollutants (POPs) and which are in the process of being added to The Persistent Organic Pollutants (Amendment) (EU Exit) Regulations.

Therefore, the Agency concludes that these specific substances should be excluded from the restriction on the placing on the market and use as the provisions in the POPs Regulations apply and already address this. However, these substances should still be taken into consideration when determining the total concentration of PFAS in firefighting foam for the purpose of this restriction (refer to Section 3.1.2.2 of this Opinion). It should

also be noted that the concentration limit specified in the restriction options are without prejudice to the limits set in the respective legislation for these substances.

The Agency intends the scope of the restriction to cover the formulation and processing of PFAS-containing FFF, even where this occurs for export of firefighting foams outside of GB. The Agency notes that formulation, processing and storage are covered by the definition of 'use' under Article 3 (24) of UK REACH.

3.1.2.2 Concentration Limits

To ensure levels of PFAS in FFF are reduced to as low as reasonably practicable and for the restriction to be effective and practical (including enforceable), the Agency considers it necessary to include a concentration limit for the amount of PFAS permitted within firefighting foam. The Agency considers that the restriction for **placing on the market and use** should apply where the **concentration of total organic fluorine from PFAS is equal to or greater than 1 mg/L** in the firefighting foam. This limit is sufficiently low to prevent intentional addition of PFAS to such foams, noting the lowest concentration considered as providing any functionality is 1000 mg/L. It is also sufficiently high to be above background levels.

The Agency notes that PFAS analysis is complicated by the large number of PFAS known to be produced and the availability of only a limited number of analytical standards. Targeted methods cannot determine all PFAS present in any foam concentrate. Therefore, the concentration limit proposed by the Agency is based on non-targeted analysis of the fluorine content of the sample. Basing the threshold on the concentration of fluorine from PFAS, instead of the concentration of individual PFAS, has several benefits to the practicality of the restriction. It allows a 'total' analytical technique to be used that is broadly available and does not require any prior knowledge of the PFAS present nor reference standards for each individual PFAS. For further information, refer to Section 6.3.2.1 of the Background Document.

3.1.2.3 Rebound and decontamination

The Agency notes that residual levels of PFAS can still be present in F3 originating from equipment that was previously used with PFAS-containing foams, including equipment which has undergone cleaning during transition (refer to Section 3.1.7 of the Background Document). This is referred to as 'rebound' and it is possible that these levels could exceed 1mg/L total organic fluorine from PFAS, despite no intentional use. To avoid a situation in which a successful transition still results in a breach of the restriction, a mechanism must be in place to recognise that a transition from PFAS-containing foam to F3 has occurred. The EU restriction of PFAS in firefighting foams has opted to use a higher concentration limit of 50 mg/L to recognise that, whilst there may be PFAS above the 1 mg/L concentration limit, it is still sufficiently below a functional amount of PFAS and it is likely that there is no "intentional" PFAS being used.

It is possible for levels of rebound to exceed 50 mg/L in some instances, and for levels to fluctuate over time. In such cases, a user that has removed their PFAS foam and fully transitioned to F3 could inadvertently breach the restriction. To alleviate this, rather than testing against a higher concentration limit in the first instance, the Agency considers that users should focus primarily on:

- replacing their PFAS-containing foam with F3
- continuing any cleaning of foam systems, tanks or infrastructure in accordance with the instructions provided by their F3 manufacturer or supplier
- ensuring appropriate handling of their unused PFAS-containing foams and waste from the use of such foams, and
- **compiling and retaining clear documentation of this process**

As the vast majority of PFAS emissions are reduced through replacement of the PFAS-containing foam (with appropriate handling of unused stocks and waste) the Agency considers a faster, more cost-effective transition to F3 could be achieved by focusing on demonstrating a successful transition, rather than on extensive decontamination and analytical testing.

Clear documentation could include retaining records of the removal, handling and disposal of PFAS-containing foams; purchase and delivery records of F3 and associated equipment; necessary changes to infrastructure to support transition to F3. As part of the PFAS management plan, users should keep this information up-to-date and make it available to the enforcing authority on request.

However, in cases where successful transition cannot be clearly demonstrated through documentation, testing may be required and in such cases a threshold of 50 mg/L total organic fluorine from PFAS for foams originating from previously contaminated equipment should be considered for enforcement purposes. This is above the 1mg/L threshold for placing on the market but allowing for some degree of rebound. If analysis is required, the same analytical approach can be used as for the placing on the market threshold (refer to Section 6.3.2.1 of the Background Document).

3.1.2.4 Other measures

The Agency considers that additional risk management measures are necessary to minimise emissions of PFAS from the continued use of FFF over the longer transition periods (i.e., 5 years and above).

These measures should not apply to portable fire extinguishers because there are already arrangements in place to manage the use, disposal and recycling which negates the need for users to provide the information required below. Also, given the proportionally low

volumes used in portable fire extinguishers compared to other uses and the fact that comparatively small amounts are held for potential use across multiple locations (e.g. including the likes of offices, cafes, restaurants), application of these measures would be difficult to manage and monitor.

Likewise, the extra measures should not apply to FRS in general. The transition periods for FRS are currently set at 18 months and the majority of the transition required by FRS should have happened by the time these additional provisions enter into force (i.e. at that point there would only be 6 months remaining). However, where FRS benefit from the extended (10 years) derogation to use PFAS-containing foams on COMAH sites that are yet to transition, it is intended that these additional provisions would apply. The FRS would work with the relevant site such that the user of the PFAS-containing foam (either private fire services on site or the attending FRS) could ensure the relevant conditions are fulfilled.

All other users of FFF containing 1mg/L total organic fluorine from PFAS (for uses with a transition period of 5 years or above), should:

- Ensure PFAS-containing foams are only used on Class B fires
- Reduce emissions to the environment and exposure to PFAS-containing foams to as low a level as is reasonably practicable.

Further, to ensure that the transition is managed and can be monitored, the Agency considers that users covered by the above should establish a ‘PFAS-containing FFF management plan’ specific for the place of use. Such a plan should include the following:

- Details of the use conditions and volumes of PFAS-containing foams on site
- Details of how emissions to the environment and exposure to PFAS-containing foams are reduced
- Information on methods for cleaning and maintenance of equipment
- Plans for accidental leakage/spillage and documentation of follow-up
- A strategy for substitution

This is the case for all restriction options considered. The Agency considers it is reasonable for these requirements to apply within 12 months of the restriction coming into force. This should provide the users with adequate time to put appropriate measures into place and to prepare the associated management plan.

To facilitate transition, the management plan should be reviewed at least annually to ensure that it is kept up-to-date. For monitoring and enforcement purposes, management plans should be kept for at least 15 years (from entry into force of this requirement) and made available to the enforcing authority on request.

Additionally, for RO2a and RO2b, the Agency has considered that the decision maker may choose to use the REACH restriction itself to address stocks of unused PFAS-containing foam (for RO2a and RO2b) and waste resulting from the use of PFAS-containing foams during the transition period or otherwise created by the implementation of this restriction (for RO2b), to further minimise potential impact to the environment from the gaps in the current regulation of PFAS-containing waste. This would include measures to:

- ensure that unused stocks and waste (including wastewater) resulting from the use of foams during the transition period are collected separately where technically and practically possible, and
- ensure their handling for adequate treatment.

In the Agency's opinion, adequate treatment includes a way in which the PFAS content is destroyed or irreversibly transformed. Waste disposal methods are discussed in Annex E.11.2 to the Background Document.

Documentation of these measures should form part of the PFAS management plan within option RO2a and RO2b.

3.1.2.5 Labelling requirements

For all options considered, labelling requirements should apply to firefighting foam containing greater than or equal to 1 mg/L total organic fluorine from PFAS when placed on the market (with the exception of portable fire extinguishers). Such a label would alert users to the presence of PFAS and support proper management of these materials during the transition periods, enabling dutyholders to ensure they are purchasing the right foams if they want to go PFAS-free.

The Agency considers that this duty should apply within a period of up to 1 year after entry into force of the restriction to allow adequate time for suppliers to make the necessary changes.

Additionally, for RO2a and RO2b and as per point 2.3 of those options, labelling requirements should apply to unused foams that contain greater than or equal to 1 mg/L total organic fluorine from PFAS. For RO2b labelling of PFAS-containing waste (including wastewater) resulting from the use of such foams will also be required. This will support identification so they can be handled effectively in a way that irreversibly transforms or destroys the PFAS content.

For the purpose of this provision, the label should include the following:

WARNING: Contains per- and poly-fluoroalkyl substances (PFAS) with a concentration equal to or greater than 1mg/L from sum of all PFAS.

This information should be visibly, legibly and indelibly marked.

The EU REACH restriction on PFAS in FFF includes a requirement to label PFAS-containing FFF when they are placed on the market in the EU from 23 October 2026. Therefore, FFF imported from the EU may already be labelled accordingly. It is therefore proposed to retain the term ‘sum of all PFAS’ to support consistency of labelling requirements. Retaining the wording would not impact on when the labelling requirements apply.

4 Justification for the opinion

4.1 Risk assessment

The Agency concludes that the PFAS used in FFF are all either perfluoroalkyl acids (PFAAs) or PFAA-precursors (Section 1.2.4 of the Background Document). This means that all the PFAS emitted to the environment from FFF will be or will transform to PFAAs, although this will be over extended time periods. As PFAAs are the common transformation products of all PFAS in FFF, the Agency reviewed the available hazard information for important PFAA groups (perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs) (refer to Section 2 of the Background Document)).

Under the UN Stockholm Convention on POPs, several long chain PFAAs have already been concluded to meet the criteria to be considered POPs, i.e. PFCA: PFOA, C9 - C21 PFCAs; PFSA: PFOS, PFHxS. The POPs criteria include persistence, bioaccumulation, toxicity and long-range travel potential.

From an evaluation of the available hazard evidence the Agency considers that:

- All PFAAs would meet the criteria to be considered very Persistent (vP) under UK REACH Annex 13, with transformation half-lives expected to be far in excess of the threshold criteria.
- All PFAAs are sufficiently mobile to reach environmental compartments of concern, which leads to their detection in groundwater and surface water in GB and other countries and the potential to travel long distances from the original point of release.
- Based on the available evidence, it appears that most PFCAs in the carbon chain length range C2 to C18 meet or are likely to meet the toxicity criterion of UK REACH Annex 13. There are data for far fewer of the PFSAs. However, the toxicological effects of those PFSAs for which information is available are comparable with those of the PFCAs. Given the confirmed or likely toxicity of PFCAs across the span of carbon chain lengths and the similarity of adverse effects of those PFSAs for which information is available, it is concluded that toxicity is associated with substances across both the PFCA and PFSA sub-groups. Furthermore, given the unknown composition of PFAS-containing FFF, formed of complex mixtures, the PFAS present in any particular foam could degrade to a combination of various PFCAs and PFSAs.

Persistent, Mobile and Toxic (PMT) or very Persistent, very Mobile (vPvM) type concerns could be considered equivalent to the other types of concerns included in Article 57(a) to (e) of UK REACH with regard to the identification of Substances of Very High Concern

(SVHCs). Two PFAS – PFBS (a PFAA) and HFPO-DA (GenX®, a PFAA precursor) – are on the UK Candidate List of Substances of Very High Concern (SVHCs) owing to PMT/vPvM-type concerns. They were added when the UK was subject to EU REACH, although the decision for PFBS was taken in 2019, when UK officials were no longer actively participating in EU discussions. These were case-by-case decisions as at that time no PMT/vPvM criteria or policy framework was in place in the EU to ensure consistency in decision-making.

The combination of persistence and mobility in particular gives rise to the potential for increasing environmental concentrations over extended timescales with continued emission and on a wide geographic scale (far from the original source), which will be slow to respond to emission reduction interventions. Rising environmental concentrations increase the potential for exposure of humans and wildlife to levels that may have (eco)toxicological consequences. This means that a quantitative risk assessment is likely to involve considerable uncertainty.

A UK Defra position statement on the risk management approach for PMT/vPvM-type concerns has since been published (Defra, 2025). Although the position statement does not provide formal PMT/vPvM criteria, it does describe how screening level data could be used to identify chemicals with the potential to reach aquatic environments that are physically and temporally remote from their original point of release. The hazard assessment (refer to Section 2 of the Background Document) describes how PFAAs fall within its scope as they have been demonstrated to reach environmental compartments of concern (particularly groundwaters) because of their persistence and mobility.

It is also necessary to consider whether PMT/vPvM substances should be treated as threshold or non-threshold concerns as this will determine how risk is assessed and what risk management actions may be required. A threshold approach assumes there is an acceptable concentration below which risks are presumed to be adequately controlled. A non-threshold approach assumes either that no threshold exists or that it is not possible to establish an acceptable concentration, and so exposure needs to be minimised to be as low as possible.

PFCAs and PFSAs tend to remain in the human body for a long-time following exposure, with continued exposure expected to lead to increased body burdens. The reported toxicological and health effects resulting from PFAS exposure include carcinogenicity (assumed to be non-genotoxic), developmental toxicity (harm to the developing child) and adverse effects in organs such as the liver or to the immune system. As demonstrated by the availability of health-based guidance values for a small number of PFAS (summarised in COT, 2022), it could be possible to derive meaningful thresholds of effect for those PFAS in firefighting foams or for their transformation products where the data are sufficient to do so. However, these data are not available for most PFAS.

In addition, PFAS-containing FFF are complex mixtures whose composition is not publicly available, and they may degrade to a combination of PFCAs and PFSAs via a range of intermediates with different degrees of persistence. It is therefore impossible to establish effects-based thresholds accounting for all relevant PFAS and their potential mixture effects. In any case, since these substances are extremely persistent in the environment, with their continued emission it would seem reasonable to conclude that any threshold would be breached over time. For persistent and mobile substances, there is also concern over difficulty in remediation. Available data indicate that it is difficult to remove PFAAs from water using currently available conventional techniques. For these reasons, taking the same approach to risk assessment as for non-threshold substances is considered the most appropriate method for addressing emissions of PFAS from FFF.

This approach aligns with the Defra position statement on PMT/vPvM-type concerns. It also aligns with the approach taken for Persistent Bioaccumulative Toxic (PBT)/very Persistent very Bioaccumulative (vPvB) chemicals, including POPs.

Following this approach, emissions to the environment are considered to be a proxy for environmental and health risks and any emissions indicate a risk that is not adequately controlled. The scale of the risk can be estimated based on the total emissions to the environment, and the restriction aims to manage these risks by minimising emissions.

The Agency has reviewed the uses and potential for environmental exposure from the formulation and use of FFF that contain PFAS (refer to Section 3 of the Background Document). There is a lack of information on any emissions from the formulation life stage. However, where testing of the FFF product takes place on such sites, there is clear evidence of environmental releases. Emissions to the environment were demonstrated for all the downstream uses, with releases to surface waters (fresh water and marine water) and soils identified.

The Agency estimates the annual emissions of PFAS associated with the use of FFF foam in GB to be ~50 tonnes. Environmental exposure modelling has not been conducted by the Agency due to the use patterns and general lack of reliable information and complexity posed by the properties of PFAAs and their precursors (refer to Section 3 of the Background Document). However, based on the emission pathways, information on the mobility of PFAAs and monitoring data, surface and ground waters were identified as compartments of particular concern. In particular, the potential for contamination of groundwaters, surface waters and drinking waters following use of PFAS-containing FFF has been demonstrated in a series of GB case studies.

4.2 Justification that action is required

The Agency has concluded that the use of PFAS in FFF presents a risk to the environment and to human health via the environment that is not adequately controlled. The hazards and exposures of concern are summarised in Section 4.1 above, as is the rationale for taking a non-threshold approach to risk assessment. Full details are provided in Sections 2 and 3 of the Background Document.

An analysis of existing GB regulatory measures which cover PFAS in FFF at various points in their life cycle can be found in Annex F to the Background Document. The Agency concludes that:

- Gaps are particularly notable in regulation with regard to controlling emissions of substances to the environment from use and end of life stages, where, as established above, these substances persist and are able to contaminate ground and surface water.
- The majority of PFAS are not designated POPs, nor classified under the GB Classification Labelling and Packaging (CLP) Regulation, and the low concentrations involved mean it is unlikely for hazardous waste classifications to be triggered. Therefore, their disposal may not be fully controlled under Hazardous Waste Regulations (The Hazardous Waste (England and Wales) Regulations 2005), and PFAS-containing FFF wastes could potentially result in releases to sewer or landfill.
- Although remediation measures are proposed (in guidance in England and Wales and in regulation in Scotland) to monitor and limit the concentration of individual PFAS in water sources, this does not prevent further emission to the environment. Increasing concentrations as a result of continued emissions could impact on the cost-effectiveness and viability of remediation of water sources.
- Owing to the non-threshold nature of the risk identified, emissions to the environment are representative of the risk. With respect to the existing pieces of legislation outlined in Annex F to the Background Document, none will be fully effective at controlling these emissions, as the majority seek to control exposure only once emissions have taken place. Restriction under UK REACH would implement control at source via supply management.

The Agency therefore concludes that the use of PFAS in FFF presents a risk to the environment, and human health via the environment, that is not adequately controlled under the existing regulatory framework.

4.3 Justification that a restriction is the most appropriate measure

The existing regulatory measures noted in Section 4.2 above (and in Annex F to the Background Document) are included as part of the baseline scenario, under which no further regulatory risk management measures are implemented. Transition away from PFAS-containing foams has occurred to varying degrees across sectors (refer to Sections 4.3.1 and 4.3.3 of the Opinion and Section 5 of the Background Document). The Agency understands the majority of GB FFF usage to now be PFAS-free although this is unevenly split between sectors of use.

The available evidence suggests that further transition under the baseline “do nothing” scenario is likely to be limited. Stakeholder engagement and market information indicate that the costs associated with transitioning to alternatives vary across sectors and users, creating differing economic incentives to switch. In addition, some users continue to report concerns regarding the effectiveness, suitability, or operational implications of available alternatives, which may act as a barrier to voluntary uptake. Taken together, these factors suggest that, for at least part of the user base, the private benefits of transition to companies may not currently outweigh the associated costs. Consequently, the Agency considers that the existing incentives for further voluntary transition are likely to be insufficient to drive widespread additional change in the absence of regulatory intervention. Accordingly, no significant further reduction in use is assumed under the baseline scenario. However, this assessment is subject to uncertainty. In particular, developments in international markets, changes in the availability or cost of alternatives, or regulatory actions in other jurisdictions could result in some additional transition over time, although the Agency currently has limited evidence on the scale or likelihood of such effects.

4.3.1 Assessment of alternatives

The hazards of alternatives to PFAS in FFF were assessed in Section 5.2 of the Background Document. Of the F3 assessed, none of the components, and therefore none of the formulations, would fulfil the P or vP criteria. Therefore, they do not have PMT or vPvM-type properties and so do not have the same concerns around the potential for long-term exposure that PFAS-containing FFF do.

However, issues around the functionality and perceived efficacy of F3 have been identified, noting that a key difference of these foams is that they are not film forming. Without an additional fluorinated film layer to help contain the volatile vapours and seal them from access to oxygen, the fire-suppressing action must come from the foam alone.

Most of the concerns that the Agency has received from stakeholders regarding the use of F3 stem from this one issue. These include:

- It potentially taking longer to extinguish fires, with more foam required to maintain sufficient foam coverage.
- The need for F3 to be applied differently and more discriminately than PFAS-containing foams.
- The need to aspirate foams (i.e., to draw air into the foam) in more situations to maintain a more substantial foam and for it to perform better. However, this compromises the range from which they can be applied (i.e. foam from a non-aspirated device will travel further).
- It being easier to break the foam blanket, resulting in re-ignition, so greater care or a modified approach to firefighting must be taken.
- F3 not performing as well in testing, or tests requiring modification to account for a different application method.

However, these concerns do not necessarily apply to all uses of every alternative foam, and industry has found ways to address them:

Concern	Management
It potentially taking longer to extinguish fires, with more foam required to maintain sufficient foam coverage.	Whilst, in many cases, it can take longer to extinguish fires without the resulting film from the PFAS-containing foam, this can be overly simplistic. “Extinguishing time” is often conflated with volume of foam required or application rate. It is also dependent on the user, application method, and matching of appropriate equipment and foam to the fire scenario. There are F3 products available on the market which have passed fire-performance tests such as those in BS EN 1568, meaning they can extinguish within the required test windows under those controlled conditions.
More foam is required than existing tanks currently hold.	Working with process safety specialists to determine *if* more foam is actually required, or if existing tank space is sufficient (within relevant safety constraints). Testing and finding a different foam which does not need as high a proportioning rate and thereby reducing the amount of foam required to be held. Retrofitting existing foam and tank infrastructure to accommodate increased

	foam quantity. (Such infrastructure change can be costly and contributes heavily to the need for longer transition periods.)
The need for F3 to be applied differently and more discriminately than PFAS-containing foams.	This is likely to apply more to application on large fires, e.g., by already trained professionals. Increased training to ensure that the foams are applied efficaciously.
The need to aspirate foams (i.e. to draw air into the foam) in more situations to maintain a more substantial foam and for it to perform better. However, this compromises the range from which they can be applied (i.e. foam from a non-aspirated device will travel further).	For FRS, this would predominantly be managed through training and adapted firefighting procedures. For fixed systems where this is a concern, for example on the decks of larger vessels, this could be mitigated through the addition of more foam monitors, reducing the distance over which each one is required deliver foam. (Such infrastructure change can be costly and contributes heavily to the need for longer transition periods.)
It being easier to break the foam blanket, resulting in re-ignition, so greater care or a modified approach to firefighting must be taken.	This is effectively the same concern as above for more discriminate foam application. This is likely to apply more to application on large fires, e.g. by already trained professionals. Increased training to ensure that the foams are applied efficaciously.
F3 not performing as well in testing, or tests requiring modification to account for a different application method	There are examples of F3 not performing as well as PFAS-containing foams in tests, however they can still succeed in those tests. That is, F3 are able to meet the standards set. F3 generally requires application to be more discriminate than PFAS foams to achieve comparable performance. As noted throughout, this is manageable through operator training.

If left unaddressed and F3 are used inappropriately, there could be potential concerns for the safety of users of firefighting foams. However, the industry is already aware that changes to application technique and adequate training are required. Demonstration of such risk mitigation can be seen in the voluntary transitions of higher risk operators, such as FRS, and their responses that they are satisfied with the performance of their chosen F3.

To note, most of these concerns do not apply to the use of portable fire extinguishers, especially those which are likely to be operated by inexperienced users, due to the locations in which they are typically installed and the fires that they are likely to be used on (often Class A).

Concerns were also raised about the inability to mix F3 from different manufacturers or with PFAS-containing foams. However, this is not exclusive to F3 and has also been a consideration for PFAS-containing foams. Furthermore, stakeholders have informed the Agency that testing should be undertaken to minimise incompatibilities from foam mixing, regardless of the type of foam being used – as advised by foam suppliers and producers.

Several other concerns have been raised by stakeholders, but the Agency notes that whilst they are concerns, they could also be viewed as potential solutions to the issues listed above. These include:

- A need for training and revalidating fire scenarios with F3.
- More vigilant visualisation of the fire and progress of suppression.
- Requirement for different application rates, methods and tools.

The Agency notes that the main issue is that these solutions come at a cost and require time to implement.

There are some other issues which can result from formulating foam products without PFAS, including increased viscosity, incompatibility with seawater and lowered resilience to extreme temperatures. However, the Agency is informed of examples where these issues have been overcome and there has been a full operational transition to F3s.

Despite issues and concerns from stakeholders that are yet to transition, there are examples of successful transition away from PFAS-containing foams to F3 across each of the analysed sectors.

The Agency acknowledges that transition comes with a cost to those stakeholders. Beyond the financial and time costs to train responders to combat fires using F3, there may be:

- Additional equipment costs in the requirement for new partitioning eductors, tanks, hoses, pipes and nozzles.

    - For industrial sites in particular, these changes may be more challenging, expensive and time-consuming, possibly needing plant redesign before retrofitting new equipment.
- The costs of downtime whilst infrastructure changes are made. Whilst these can be mitigated in some instances by taking advantage of scheduled maintenance, that would require a longer time period for transition.
- Costs related to any cleaning of existing equipment and the appropriate disposal of contaminated rinse solvent.

Nonetheless, many stakeholders across each sector have already clearly determined that F3 are a viable alternative, are worth the investment to switch, and have successfully transitioned.

That is not to say that each stakeholder in every sector could transition immediately i.e. with F3 as a drop-in alternative. However, the fact that stakeholders across each sector have transitioned indicates that questions relating to foam efficacy are not necessarily insurmountable obstacles. Rather, the Agency considers that sufficient time is needed for users to work with suppliers to find appropriate foams for their use, and to train with those new foams to ensure they can perform efficaciously.

The Agency therefore considers that alternatives are broadly available and viable and that the primary barriers to transition are cost and time. That is, alternatives to PFAS foams are **technically feasibl**e and the challenges are predominantly related to **economic feasibility**.

The Agency is aware that there will be instances where GB stakeholders have not yet been able to invest in researching a safe transition away from PFAS-containing foams. This may be due to perceived ineffectiveness of F3, not having legislative certainty that PFAS-containing foams will be prohibited in GB, or a concern that there is not currently an appropriate F3 for their use. To account for this, the Agency has considered longer transition periods where appropriate.

4.3.2 Risk Management Options

As part of the restriction process, the Agency has considered the use of both regulatory and non-regulatory measures - this analysis can be found in Section 6.3 of the Background Document

4.3.2.1 Non-regulatory options:

- Economic instruments such as taxation: unlike regulatory charges, which may be imposed to recover the costs of regulation, environmental taxes are fiscal measures requiring government and parliamentary approval. This makes them less straightforward for a government department outside of the UK Treasury to introduce independently.

- Stewardship programme: this would rely on voluntary transition but sign up across all users and sites could not be guaranteed, especially if they were not convinced on the viability of alternative/ease of transition. Therefore, it is unclear how effective such a programme would be.

- Communication with users and labelling of foams: this would aim to "nudge" behaviour away from use by providing more information about risks but also the alternatives. However, as with the stewardship programme this would be a voluntary process with no guarantee of success, especially given that the users of the PFAS-containing foams are not the same people who face the risks.

4.3.2.2 Regulatory options other than REACH

Regulatory options outside of REACH that could control the identified risks were limited to consideration of PFAS specific legislation, which, although the Agency thought a useful and viable option – particularly as this could take a cradle-to-grave approach at managing the life cycle of PFAS (from manufacture/formulation - to use - to waste and disposal). However, this would require significantly wider governmental and parliamentary engagement and is outside of the scope of this UK REACH restriction request. Such an approach would likely be more appropriate and relevant to address PFAS uses more broadly, not just in firefighting foams.

Amendment of the relevant existing waste/permitting legislation to deal with waste from the use of PFAS-containing foams was not assessed as a standalone regulatory option as this would not manage all the identified risks, may not result in transition to F3, and would still allow use even where waste could not be controlled. The Agency therefore concluded that this measure was not an option without combination with, or existence of, a restriction on use and placing on the market.

4.3.2.3 Regulatory options using REACH

Three REACH restriction options have been identified, all options will:

- Result in restricting PFAS-containing foams from being placed on the market in GB and used where they contain equal to or greater than 1mg/L of total organic fluorine from PFAS.
- Establish sector/use specific transition periods.
- Require the labelling of foams which are placed on the market during the transition period where they contain equal to or greater than 1mg/L of total organic fluorine from PFAS.

Further, for uses with transition periods of 5 years and above (with the exception of portable fire extinguishers) each option will:

- Require emissions to the environment and direct and indirect human exposure to PFAS-containing foams to be as low as reasonably practicable.
- Require users of such foams to establish and maintain a PFAS-containing firefighting foams' management plan specific to the place of use.

RO1: also introduces a 'standard management plan' requiring users to set out details of the volumes of PFAS-containing foams on site, details of the use conditions and how emissions are controlled, details on the type and methods of cleaning and maintenance of equipment, plans (and follow-up) in the event of accidental leakage/spillage of PFAS-containing foam and a strategy for substituting PFAS-containing foams with fluorine-free alternatives. This option requires that once considered as waste, any foams or associated waste products from use should be handled in accordance with measures prescribed by the relevant enforcing authority, thereby using appropriate legislation outside of REACH to manage waste, which reflects what normally happens in other REACH restrictions.

RO2a: includes the additional requirement for users to ensure the labelling and collection of stock of unused foam, and to ensure its handling in such a way that PFAS content is destroyed or irreversibly transformed.

In addition to the standard requirements outlined in RO1, information on the collection of unused foam and measures to ensure adequate treatment of this should also be included in the management plan.

In addition to the specific requirements for unused stocks outlined above, this option also requires that once considered as waste, any foams or associated waste products from use should be handled in accordance with measures prescribed by the relevant enforcing authority. As above, these measures would be outside the scope of the REACH restriction.

RO2b: includes an additional requirement for users to ensure the labelling and separate collection of stock of unused foam **and** PFAS-containing waste, including wastewater, originating from the use of PFAS-containing foams (where this is technically and practically possible) and also to ensure their handling in such a way that PFAS content is destroyed or irreversibly transformed.

In addition to the standard requirements outlined in RO1, information on the collection of unused foam **and** PFAS waste and measures to ensure adequate treatment of this should also be included in the management plan.

4.3.3 Transition periods

The proposed transition periods, which the Agency considers appropriate under all restriction options, are provided in Table 1 above. The proposed periods are intended to

support an orderly transition and ensure that users can adapt to suitable alternatives without jeopardising safety. These periods have been determined using those derived in the EU restriction of PFAS in FFF as a foundation and supplemented with GB specific information obtained during the development of this proposal.

Unless specified below, the Agency considers that a 5 year transition period should apply to both placing on the market and use of FFF containing equal to or greater than 1mg/L total organic fluorine from PFAS.

A 5 year period will allow for a manageable and orderly replacement of PFAS-containing foams (and equipment where necessary), avoiding sudden disruptions to supply chains and helping ensure fire safety is not compromised during the transition. It also seeks to accommodate the current situation with regard to the high temperature incineration (HTI) capacity in GB, reducing spikes in the generation of unused stocks which could result in improper or delayed disposal and the need for stockpiling/storage of waste.

The Agency has analysed several specific sectors (refer to Sections 3.1.6 and 5.3.4 of the Background Document) and a summary of the rationale for the relevant transition periods for each of those sectors is provided below. In some cases, deviations from the general 5 year transition period may be warranted:

4.3.3.1 Ready-to-use

A **6 month transition period** should apply to **placing on the market** of fire extinguishers (defined by BS EN3-7, BS EN-1866 and BS EN-16856) which contain PFAS.

A **5 year transition period** should apply to the **use** of fire extinguishers (defined by BS EN3-7, BS EN-1866 and BS EN-16856) which contain PFAS.

Smaller (3-9 litre) portable foam extinguishers utilising F3 are readily available on the GB market. These represent the majority of portable extinguishers which are ubiquitous across many industries. No evidence has been forthcoming to suggest that transitioning to these would raise any problems.

Larger volume products which use F3, 50-150 litre wheeled units, exist although are not as widely available. The use of these is more specialised, typically in areas that require a greater volume of fire suppressant, but a fixed system is not in place or appropriate.

The largest of these products have the lowest availability but are also most often deployed on civilian vessels. Owing to current maritime regulations, PFAS-containing foams (except for those containing PFOS) can continue to be used on the high seas (see Marine Section below). As such, with little international motivation to change, many 150 litre units on the market still currently contain PFAS.

A short transition period for *placing on the market* ensures PFAS-containing portable fire extinguishers are readily removed from sale for stakeholders that require new

extinguishers. It also ensures that PFAS-containing foam is unavailable for stakeholders undergoing scheduled extinguisher replacement, which typically occurs every 5 years.

However, a 6 month transition period for *use* could lead to significant pressure on suppliers and a shortage of F3, given the widespread use across all industries. Whilst some users will transition away from foam to other firefighting media (water, powder, CO_2), the risk of F3 supply interruption remains. Therefore, the Agency suggests aligning with the typical 5 year replacement schedule for portable extinguishers, especially given that the principal uses are emergency and infrequent, and the individual volumes are small.

The 6 month *placing on the market* transition period differs from the EU, where 12 months have been allowed for the placing on the market of fire extinguishers in general, and 18 months for those containing alcohol resistant foams.

According to comments received during ECHA's public consultations, the primary reason given for a longer transition period for alcohol-resistant foams was a general, somewhat unsubstantiated claim that alternatives were not available, but that 18 months may be a sufficient resolution time. Given that GB imports FFF from the EU, and the EU restriction is likely to have been active for at least 12 months by the time this restriction could enter into force, a shorter transition period of 6 months for the placing on the market of all fire extinguishers is proposed.

4.3.3.2 Fire and Rescue Services

An **18 month transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams for FRS.

F3 are already in use with a number of FRS, with some having transitioned over 5 years ago and one as early as 2011. Several other FRS were also planning transitions as of 2022. Such long-term use and willingness to transition suggests technical viability of F3 alternatives. Some FRS that have transitioned are in areas with multiple upper tier COMAH sites, indicating further confidence in the ability of F3 to tackle fires in more difficult conditions.

The National Fire Chiefs Council advises that, whilst it would be possible for the remainder of the sector to transition, an 18-month transition period would be challenging. This is primarily due to funding cycles and procurement of new equipment, which is likely to be required to correctly deploy alternative foams because of the different physical properties of F3. They suggest a minimum 3 year transition period to ensure FRS are fully equipped to deploy F3. However, without further substantiation on the scale of the remaining transition, the Agency does not currently suggest increasing the transition period. Given that the costs of transition would exceed simply the cost of new foam and require the purchase of new equipment, the Agency also does not suggest a shorter transition period.

Where FRS may attend incidents where the use of PFAS-containing foams remains lawful, e.g. at a COMAH site during the relevant transition period, they should be allowed to use those foams as required. Whilst FRS which have transitioned to F3 would predominantly use their F3 to tackle a fire, they may be required to additionally interact with PFAS-containing foams on site, such as in fixed systems. As such, **for use of PFAS-containing foams by FRS at COMAH sites, the 10 year transition period should apply**.

Whilst use of PFAS-containing foams at COMAH sites (particularly those with large atmospheric storage tanks) could form part of a necessary emergency response, the Agency is assured by the presence of mutual aid agreements utilising F3, and robust emergency networks of F3 delivery that can supply many tens of thousands of litres of F3 nationally, as required.

As a final note, the Channel Tunnel may require compliance with both EU and UK REACH restrictions. This suggests some benefit in GB transition periods aligning with ECHA-proposed transition periods in this case.

4.3.3.3 Petrochemical, chemical and industrial sites

A **10 year transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams at COMAH sites.

There is evidence to suggest that transition to F3 has happened at some COMAH sites, with more sites reportedly in the process of transition, often to coincide with planned downtime and maintenance as this reduces cost of taking a site out of production and fire safety being compromised. FRS that cover multiple sites have also transitioned to F3 alternatives and have well considered stocks of foam and response plans in place should a fire break out, plus further contingency plans at a national level.

There are a significant number of COMAH sites, many with a legal requirement to hold large volumes of firefighting foam and a defined minimum rate at which that foam must be delivered. This sector is responsible for holding the greatest proportion of foam stocks. The scale of transition for this sector is significant.

In some cases, a single PFAS-containing foam can be used across the whole site, due to the more forgiving chemistry of these products. Replacement PFAS-containing foams are frequently drop-in alternatives. This is often not the case for F3. Different foams may be required to cover different parts of a site e.g. where different chemical products are made, used or stored, and due to the different chemistries of F3. Consequently, they are rarely drop-in replacements.

The foams are frequently deployed through extensive fixed systems with specific eductors, aspirators and nozzles, all of which may need replacing as part of a transition to F3. Additional or larger foam storage tanks may also be required. These changes require (parts of) a site to be shut down during replacement to ensure fire safety is maintained, a

cost which can be minimised by making these changes during scheduled maintenance periods. Significant plant changes will likely require long-term design and planning, and in some cases recertification. As such, suitable lead times will be necessary.

In summary, a successful transition requires sufficient time, to:

- Identify an appropriate foam, which may include working with a formulator to develop tailored products – especially where multiple products are required.
- Compatibility testing for multiple foam use.
- Identify and procure equipment suitable for the new foam.
- Plan and safely retrofit new equipment.
- Ensure staff are trained with application techniques commensurate with the new foam.

A longer transition period also helps to minimise spikes in unused foam disposal, allowing potential for greater HTI capacity or other solutions to be brought online over time to deal with the significant volumes from this sector.

4.3.3.4 Offshore

A **10 year transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams in the offshore oil and gas sector.

There are examples of successful transition, such as Equinor's complete transition away from PFAS-containing foams on their platforms on the Norwegian continental shelf. This is a clear example of overcoming many of the challenges commonly identified by industry: seawater compatibility, low temperature operation, identifying a suitable foam such that greater volumes are not required, cleaning and removal of unused PFAS concentrate.

However, it is acknowledged that such success is not immediately transferable to others in the industry. Whilst this provides evidence that F3 are able to work in these conditions, as with land-based petrochemical sites, the path to successful transition still requires sufficient time, to:

- Identify appropriate foam(s), which may include working with a formulator to develop tailored products.
- Identify and procure equipment suitable for the new foam(s).
- Plan and safely retrofit new equipment.
- Ensure staff are trained with application techniques commensurate with the new foam(s).

With the additional challenge of making these changes at sea.

Despite the above, the Agency is aware that there remain some instances whereby a single appropriate F3 is not currently available. Multiple F3 may be required for different purposes, requiring further compatibility testing, and the space constraints of an existing

platform may not permit the increased volume requirements without significant remodelling.

To accommodate these challenges, a longer transition period is considered appropriate.

4.3.3.5 Marine

A **10 year transition period** should apply to **placing on the market and use** of PFAS-containing FFF on board civilian vessels, **where PFAS-containing foams are aboard the vessel prior to entry into force of the restriction**.

For smaller vessels, firefighting is conducted with portable and mobile fire extinguishers. For pleasure vessels and areas where there is a low likelihood of a Class B fire, foam-based extinguishers may not be required. As such, a transition to alternatives is not expected to be problematic and the fire extinguisher transition periods would apply.

Challenges emerge for engine rooms, cargo areas and decks – in particular when large volumes of petrochemicals are transported. For these, the situation is similar again to COMAH sites and the offshore sector with fixed systems, retrofitting, requirement for additional monitors, and multiple foam types.

As is noted in the Offshore Section above, the challenges relating to foam use at sea and in cold environments can be overcome with appropriate research and working with foam providers. As such, alternatives are available and will continue to become more available over time. The Agency acknowledges that F3 performance remains unproven in real-world use on the largest tank fires, which would include those at sea as well as on land. However, foam producers continue to certify foams against appropriate standards qualifying them for use at sea.

The primary challenge is balancing the need for vessels that already have PFAS-foams in their onboard systems to be drydocked for maintenance, with availability of drydock capacity. A longer period allows for a more orderly and cost-effective transition, and the Agency therefore considers that a 10 year transition period would be appropriate. Where this is not required, for example where PFAS-containing foams are not present on the vessel prior to the restriction coming into force, **the standard 5-year transition period should apply**.

The Agency notes that there are enforcement challenges regarding the use of PFAS-containing foams on international vessels. As is acknowledged in ECHA's Background Document to the Opinion on PFAS in firefighting foam (ECHA, 2023), further action involving the International Maritime Organisation (IMO) will be required to ensure that restrictions on PFAS on vessels traversing the high seas are fully functional and enforceable. Aligning with the EU minimises these challenges on both sides for seaborne trade with the EU, whilst also bolstering a more international position and allowing time for action by the IMO.

4.3.3.6 Aviation

A **5 year transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams at civil aviation sites (airports and aerodromes).

Most GB aerodromes have already fully transitioned to F3, and several major international airports in GB have reported successful transitions with no adverse impact on operation. Stakeholders consider that whilst non-fluorinated foams require different firefighting techniques, training and application, they can be equivalent to PFAS-containing foams in their ability to extinguish aviation fires.

Whilst the above considerations allay most of the Agency's concern regarding the ability of this sector to transition, it is acknowledged that some challenges remain. In particular, civil aviation sites remain subject to various regulatory approvals and operate with large volumes of foam, including within fixed systems.

As such, the Agency does not consider a shorter transition period appropriate and suggests that the general 5 year transition period is applicable.

4.3.3.7 Defence

A **5 year transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams by the military, not including military vessels (ships and submarines).

Defence is considered to include:

- sites on land either owned by the Ministry of Defence (MoD), or
- where the MoD has rights to the land, or
- assets owned by or operated by the MoD, or
- assets owned or operated on behalf of the MoD.

Use of FFF by MoD resembles several civilian sectors, including aviation, marine and transport, with the added hazard of fires in proximity to explosives or munitions. In many cases, where the primary hazard is explosive, water, drenching and submersion are the primary fire suppression methods.

Airbases will contend with the same risks as the civilian aviation industry, where much transition away from PFAS foam has already occurred and alternative foams are readily available. Most airbases also have a dedicated fire and rescue service, similar to civilian municipal fire and rescue, that services the MoD site and the surrounding residential areas in cases of emergency. As with civilian airports, alternative foams are readily available and transition to alternatives appears viable.

MoD fuel storage locations do not fall under COMAH regulations, instead, they are subject to the Major Accident Control Regulations (MACR). As such, firefighting use at these sites would not be derogated for 10 years. Nonetheless, the MoD is intending to phase-out land-based PFAS use in firefighting foams within the standard 5 year transition period

proposed. This may be expected given the less diverse nature of these sites, relative to the variety of chemical plants and fuel refineries under COMAH, and the more centralised control over these sites.

A **10 year transition period** should apply to **placing on the market and use** of PFAS-containing firefighting foams on board military vessels. A longer transition period is considered appropriate to account for specific defence requirements and to allow for any refitting of existing vessels to accommodate F3, including tank and infrastructure changes as noted for the marine sector.

4.3.3.8 Training and testing

An **18 month transition period** should apply to **placing on the market and use** of PFAS-containing FFF for training and testing, except testing of firefighting systems for their function.

Even where PFAS-containing foams lawfully remain on the market and in use e.g. during transition periods, there should be no need to deploy PFAS-containing foams for training. A variety of fluorine-free training foams are available. The tactics for PFAS-based foams can still be delivered in training, where required, but utilising alternative foams.

Most commonly, such training is conducted by FRS. This 18 month transition period aligns with the transition period for FRS to fully transition to F3.

Testing is intended to cover both the testing of new and existing PFAS foams by formulators, and the compatibility testing of PFAS foams with the various fire hazards that may be present on site.

Formulators and foam producers should be discouraged from developing and testing new PFAS foams and formulation changes, instead focusing on developing new F3.

Users should be discouraged from testing PFAS foams for their uses and encouraged to transition to F3 instead.

An exception is to be made for PFAS-containing firefighting systems that are required to be deployed as per safety regulations, i.e. tested for their function. For example, where PFAS-containing foams lawfully remain in use during transition periods, there may be a safety requirement for annual testing, to ensure a fire suppression system works. Or a Marine and Coastguard Agency surveyor inspecting a ship may require a demonstration that the foam system can successfully deploy. In these instances, small amounts of PFAS-containing foams may be released.

4.3.3.9 Review Period

The Agency notes that the EU restriction on the use of PFAS in FFF includes a review period for those uses with a longer (i.e. 10-year) transition period due to the identified

uncertainties regarding the suitability of alternatives. That is, **more** time may be required, to be assessed as the end of the 10-year period approaches. The decision maker may want to take this into account when making their decision.

4.3.4 Effectiveness in reducing identified risk

[For further detail please see Section 6.3.2.1 of the Background Document]

4.3.4.1 Placing on the market/use

The three options presented target the placing on the GB market and all uses of PFAS in FFF. This would result in the eventual complete elimination of additional PFAS-containing FFF being placed on the market or used within a decade of the legislation entering into force and therefore avoid associated future PFAS emissions in GB from the use of FFF. As all restriction options cover the use of PFAS in FFF, formulation of PFAS-containing foams (including for export only) would also be prohibited in GB.

Ultimately, all restriction options would prevent on-going releases of PFAS from FFF by preventing placing on the market and use. Therefore, all are effective measures to reduce the identified risks to the environment and human health via the environment.

4.3.4.2 Additional risk management measures

The Agency has also considered the effectiveness of the additional risk management measures provided in RO1, RO2a and RO2b, which are considered necessary to minimise the impact of emissions into the environment resulting from the ongoing use of PFAS-containing foams during the longer transition periods of 5 years or above (excluding portable fire extinguishers). This includes the requirements to reduce emissions and the establishment of a PFAS-containing FFF management plan for the place of use: requiring documentation of use conditions and volumes of PFAS-containing foam, details on cleaning and maintenance of equipment, accidental spillage arrangements and a strategy for substitution to F3. These are assessed to be effective measures to reduce emissions of PFAS resulting from the continued use of these foams during the extended period of transition.

4.3.4.3 Risk management of unused foams and PFAS-containing waste

The identified restriction options also include provisions to ensure adequate handling of waste generated from the use of PFAS-containing foams, or unused stocks generated as a consequence of the restriction.

Under RO1 waste is dealt with under the current waste management framework, which reflects the usual process for other REACH restrictions. RO2a and RO2b mandate the separate collection and treatment of unused PFAS-containing foam stocks. For RO2b, this requirement extends to PFAS-containing waste and wastewater where technically and practically feasible. Furthermore, RO2a stipulates that any other generated PFAS waste

must be managed under current the waste framework outside the scope of the REACH restriction.

The Agency concludes that under the current waste management framework RO1 may be only partly effective at controlling the risk from unused foams and waste. RO2a is effective at controlling the main source of emissions (unused PFAS-containing foams) throughout the longer transition periods and results in a high level of reduction in emissions. However, as the approach to other PFAS-containing waste is the same as RO1, it is also only partly effective (as above). RO2b is effective at controlling emissions from unused foams and waste in sectors with longer transition periods but lacks clarity on what is technically and practically possible particularly on PFAS-containing waste. Where they can be costed, the proportionality of these measures is discussed in the socioeconomic analysis (refer to Section 4.3.5.3 of this Opinion).

4.3.5 Socioeconomic analysis

[Full details of the analysis in the SEA can be found in Section 6 of the Background Document and Annex G to the Background Document.]

The market for FFF exhibits significant negative externalities because the market price of PFAS-containing foams does not reflect the external costs associated with environmental release. PFAS are stock pollutants; once emitted, they persist for decades or centuries and may lead to increasing body burdens in humans and contamination of critical drinking-water sources.

The Agency estimates that while approximately 59% of the GB market has already transitioned to F3 alternatives, further voluntary transition is unlikely due to heterogeneous transition costs and perceived efficacy concerns in high-hazard sectors like (petro)chemicals (Background Document Section 5.3.4.2) and offshore installations (Background Document Section 5.3.4.3). Without intervention, an estimated 2,060 tonnes of foam concentrates will be placed on the market annually, and 50 tonnes of PFAS will continue to be emitted annually in GB.

4.3.5.1 Methodological Approach to Socioeconomic Analysis

In line with standard socioeconomic practice, the Agency first models the analytical baseline representing what will happen during the 30-year appraisal period without the restriction, followed by modelling the situation under the restriction scenario across the same timeframe. The differences between the baseline and the alternative scenarios are then the impacts (costs and benefits) of restriction. Due to the high scientific uncertainty involved in monetising the benefits of the restriction, the Agency does not directly compare the benefits and costs attributable to the restriction using benefit-cost ratios and/or the net present value of benefits minus costs. Instead, benefits are proxied by emission reductions so that cost-effectiveness analysis can be undertaken and used to assess the

proportionality of the restriction by comparing the cost per unit of emission reduction (£/kg) to relevant informal policy reference points[3].

For the purpose of the socioeconomic analysis, the three restriction options described earlier are broken down into their three constituent risk management policy measures: (1) switching from PFAS to F3, (2) appropriate disposal of unused PFAS-containing foam stock, and (3) firewater management. Each restriction option can be represented as a combination of these policy measures:

- RO1 = (1) switching from PFAS to F3
- RO2a = (1) switching from PFAS to F3 **+ (2) appropriate disposal of unused PFAS stock**
- RO2b = (1) switching from PFAS to F3 + (2) appropriate disposal of unused PFAS stock **+ (3) firewater management**

Although the intent of RO2b requires the collection and adequate treatment of PFAS-containing waste other than firewater, this cannot be costed due to the uncertainties with the volume and type of waste generated [see below].

The cost components and corresponding emission reductions are estimated for each of these policy measures and restriction options. The cost items include:

- Replacement cost of switching from PFAS to F3 (input costs)
- Cost of capital changes (capital cost)
- (not monetised; see Background Document Section 6.4.2) Cost to users including cost to manufacturer (re-formulation), familiarisation cost, cost of preparing and maintaining PFAS management plan, and labelling cost; enforcement cost to authority
- Cost of waste management: The EU Guidance for Transitioning to Fluorine-Free Firefighting Foams (2026) highlights that the transition generates several distinct waste streams including
    - PFAS-containing firefighting foam (cost of unused stock disposal)

[3] One such reference point looks at the cost-effectiveness of previous chemicals policy interventions proposed for regulating PBT type substances (Oosterhuis and Brouwer, 2015). In their study, the authors find that regulation on PBT substances with a Cost Effectiveness Ratio (CER) below £1,628/kg has been considered cost-effective from a decision-making standpoint, with CERs above this falling into a ‘grey zone’. Different PBT substances will have different impacts on humans and the environment and so an explicit CER threshold deemed ‘acceptable’ suffers from limitations, but this nonetheless provides useful context in that the CER threshold derived reflects societal acceptance of these past decisions.

- PFAS-containing firefighting run-off water (firewater collection and disposal cost)
- PFAS-containing water from cleaning of equipment including PPE (decontamination cost)
- PFAS-containing system components in different parts of the firefighting system (decontamination cost; capped by cost of replacing components)
- PFAS-containing soil (not monetised)
- PFAS-containing equipment, e.g. PPE (not monetised)

The Agency adopts a bottom-up approach which disaggregates each use sector (e.g. petrochemical, marine) into sector subpopulations (e.g. Large Atmospheric Storage Tank (LAST) COMAH sites, lower-tier COMAH sites in petrochemical sector) and applies different parameter values for different subpopulations. This approach differs from the approach taken in the original restriction dossier where market totals were split using sector shares, with common or similar assumptions across sectors. This revised approach has the strength of capturing the following across and within sectors:

- Variability in capital requirements and timing of capital events (driving capital cost)
- Different behaviour of stock top-up, use and disposal of sites (driving replacement cost and unused stock disposal cost)
- Differences in firewater collectability (driving firewater management cost)
- Differences in F3 alternative availability and foam volume uplift (driving replacement cost)

This model tracks stocks, flows (purchase, use, disposal), and emissions of PFAS into the environment for each sector subpopulation under the baseline and restriction scenarios. Costs and reduction in emissions are aggregated from the subpopulation level upward. This structure permits a marginal abatement cost curve (MACC) to be drawn by sector and subpopulation, and thus allows evaluation of cost-effectiveness of the various risk management measures under each restriction option at a more granular level. This also allows discussion of transition period options by sector subpopulation.

The specifics of the approach, modelling and calculations can be found in the Background Document and associated Annexes.

4.3.5.2 Key Findings

Substitution and capital costs: The primary cost drivers are foam substitution (£201.3m in present value (PV) terms 2024 prices) and capital replacement of equipment (£411.8m

in PV terms 2024 prices; including specific components of foam delivery systems such as proportioner pumps and jets and nozzles for discharge). The (petro)chemical sector accounts for approximately 87% of total transition costs due to high stock-holding requirements and the complexity of fixed-system capital equipment modifications. The variation of these costs is the main driver of the differences in costs and cost-effectiveness across and within sectors. For example, there are no expected capital costs attributable to the restriction for the ready-to-use sector because unlike other sectors, no fixed systems need to be modified to use PFAS-free foams. The main cost item in this sector is the price difference between PFAS-free and PFAS-containing foams.

Cost-effectiveness ratios are expressed as incremental cost-effectiveness ratios (ICER), which is the additional cost of a certain (incremental) measure divided by the additional reduction in emission as a result of the measure. Table 2 below lists the costs and reduction emissions of the different measures under the restriction options. The rows in the table can be interpreted as the different individual measures included in the restriction options. Driven by the high capital cost for some sectors requiring fixed-system retrofits for transitioning to F3, the cost-effectiveness ratio for the capital replacement measure is higher than other measures[4] (£1,158/kg). The additional requirement of **appropriate disposal of unused stock (via HTI currently) is highly cost-effective**, with an ICER of only £99/kg. This reflects the large volume of PFAS stock prevented from entering the environment via wastewater treatment plants (WwTPs) or landfills at relatively low marginal cost. **Firewater management appears to be cost-effective** as well with an ICER of £143/kg. However, this should be **interpreted with caution** as this ratio does not reflect the complete picture as firewater management in some sectors (e.g. marine or offshore) may not be possible, or the cost is not monetised and is not included in the calculation. **This ICER of £143/kg should not be interpreted as a robust measure of cost-effectiveness of firewater management and does not mean that this measure is indeed proportionate (see section 4.3.5.3)**.

The estimated PV costs of restriction, across a 30-year appraisal period, are £613.2m, £696.4m and £704.0m for RO1, RO2a and RO2b, respectively. Under RO1, emission is reduced by at least 529.3 tonnes, with RO2a reducing emissions by at least 1368.3 tonnes and RO2b reducing emissions by 1421.6 tonnes.

[4] An exception to this is for measures regarding the decontamination of equipment. These are not assessed as part of the main analysis since decontamination is not an intended requirement of the restriction. They are however considered as a separate analysis in Annex G. This shows that while equipment decontamination (including rinsewater management and testing) prevents rebound emissions to a certain extent, the cost is extreme relative to the risk reduction. The ICER for decontamination is estimated at £130,536/kg, far exceeding the Oosterhuis and Brouwer (2015) informal policy reference point for PBT/PMT substance regulation. Note that these costs will be higher if users are required to regularly collect samples and test to ensure compliance, while the emissions through rebound are expected to trail off over time after transition. These further call the proportionality of a strict end-of-pipe limit into question.

The cost-effectiveness ratios by sector also support the proposed transition periods for different sectors and subpopulations. For the petrochemical and marine sectors with a proposed 10-year transition period, reducing the transition period to 5 years will increase premature stock destruction, increase dry-dock premium (marine only), accelerate capital cost but increase emissions reduction. For both sectors, a 10-year transition period is slightly more cost-effective than a 5-year transition period.

Offshore refineries (petrochemical sector) is the sector subpopulation that is the least cost-effective. It has a cost-effectiveness ratio of £2,742/kg under RO2b meaning that for each kg of PFAS emission reduction, £2,742 of restriction cost is required (£2,804/kg under RO2a and £11,745/kg under RO1). This cost is driven by high offshore capital cost and limited firewater containment. Similarly, **LAST refineries (petrochemical sector)** is the second least cost-effective (£766/kg under RO2b; £781/kg under RO2a; £4,222/kg under RO1). These cost-effectiveness ratios do not change the overall conclusion but argue for particular implementation attention in these sectors in order to ensure costs are minimised.

Table 2: Overview of costs and emission reduction of the restriction options

Cost type	PV estimate (30 years, million)	Emission reduction (30 years, tonnes); % of baseline emission in parentheses	Incremental cost-effectiveness ratio (ICER) (£/kg)	Cost-effectiveness ratio (CER) (£/kg)
Foam substitution	£201.3m	529.3t **(35%)**	£1,158/kg	
Capital replacement	£411.8m			
Enforcement (to authority)	Not quantified*			
Familiarisation	Not quantified*			
Cost to manufacturers	Not quantified*			

Cost type	PV estimate (30 years, million)	Emission reduction (30 years, tonnes); % of baseline emission in parentheses	Incremental cost-effectiveness ratio (ICER) (£/kg)	Cost-effectiveness ratio (CER) (£/kg)
Administration cost (management plan, labelling)	Not quantified*			
RO1 total	£613.2m	529.3t **(35%)**		£1,158/kg
Incineration/disposal of unused stocks	£83.2m	839.0t **(56%)**	£99/kg	
RO2a total	£696.4m	1368.3t **(91%)**		£509/kg
Firewater management (where this is possible and monetised)	£7.6m	53.4t **(4%)**	£143/kg	
RO2b total	£704.0m	1,421.6t **(94%)**		£495/kg

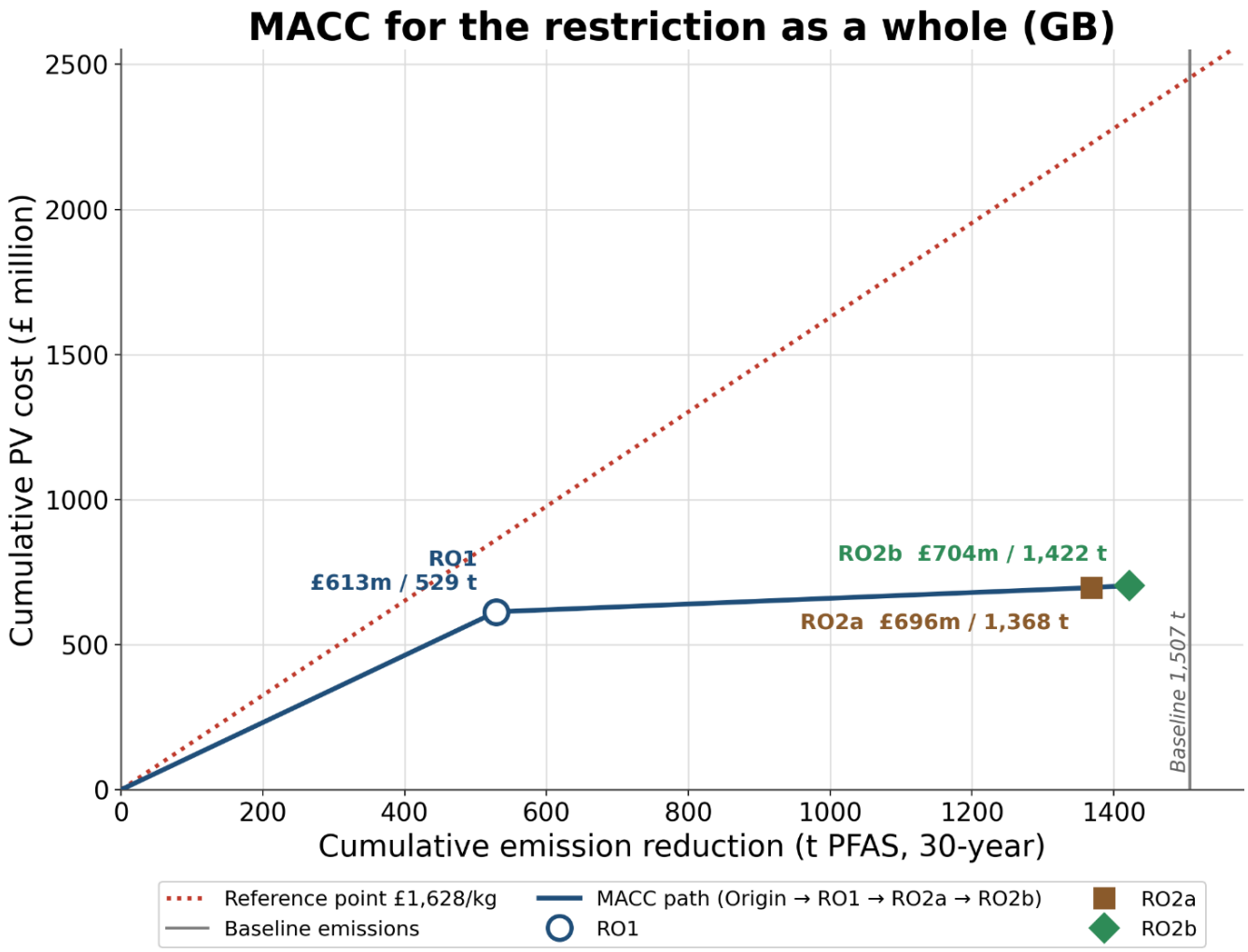
*The Agency has not monetised these costs and expects these costs to be insignificant compared to other monetised costs.

Figure 1 below shows the costs of restriction, reduction in emissions and cost-effectiveness by different restriction options. Starting from the origin (baseline), RO1 brings an emission reduction of 529.3t (35% of baseline emissions) at a cost of £613.2m. The slope of the line (change in cost divided by change in emission reduction) represents the ICER from baseline to RO1, at £1,158/kg. From RO1 to RO2a, the additional requirement of appropriate disposal of unused stock reduces emissions further by (1368.3t-529.3t=839.0t; 56% of baseline emissions) at an additional cost of (£696.4m-£613.2m=£83.2m). The ICER is £99/kg, represented by the flatter line from RO1 to RO2a. From RO2a to RO2b, the additional requirement of firewater management reduces emissions further by (1421.6t-2368.3t=53.4t; 4% of baseline emissions) at an additional cost of (£704.0m-£696.4m=£7.6m), giving an ICER of £143/kg.

The slope of the dashed line gives the informally established policy reference point for PBT/PMT substance regulation for comparison (regulations on PBT substances with a

CER below £1,628/kg have been considered cost-effective from a decision-making standpoint). The ICER of all measures (substitution, unused stock disposal and firewater management) and CER of all three options (RO1: £1,158/kg; RO2a: £509/kg; RO2b: £495/kg) are below this reference point, implying these measures options are considered acceptable on cost-effectiveness grounds based on past policy decisions.

Figure 1: Marginal abatement cost curve (MACC) of the restriction



4.3.5.3 Proportionality

The Agency concludes that a restriction on the placing on the market and use of PFAS-containing FFF is appropriate and does not appear disproportionate relative to other chemical interventions on PBT type substances. Specifically:

- RO1, RO2a and RO2b are deemed proportionate as they are below the informally established policy reference point for PBT/PMT substance regulation[5] (exception: subpopulations within the petrochemical sector mentioned above).

- Substitution (transitioning from PFAS to F3) and the requirement for appropriate disposal of unused stock achieves an optimal level of emission reduction in terms of cost-effectiveness compared to other combinations of measures. Requiring substitution alone without ensuring appropriate disposal of unused stock leaves the bulk of available abatement of emissions on the table because legacy stock under the baseline disposal pathways continue to release PFAS.

- Firewater management is slightly less cost-effective but still below the informal policy reference point. The potential emission reduction is limited in comparison (4% of baseline emissions vs. 56% for appropriate disposal of unused stock) because firewater collection may not be possible or monetised in some sectors.

- Firewater management cost for some sectors (where firewater collection may not be possible) and decontamination of PFAS-containing soil are not monetised. Nonetheless, over 90% reduction of baseline emissions is expected from transitioning from PFAS to F3 and appropriate disposal (using HTI) of unused PFAS-containing foam stock. This brings the proportionality of further waste management beyond the disposal of unused stocks into question, especially when the Agency is unable to provide robust cost estimates of management and disposal of other PFAS-containing wastes (listed in Section 4.3.5.1).

4.3.5.4 Robustness

The above conclusions on cost-effectiveness hold under different assumptions, including adopting the low and high sets of values for creating an upper bound and a lower bound of cost-effectiveness. The key results of this analysis fall within the ranges of results extrapolated from ECHA's analysis using different methods (such as apportionment by percentage of population or gross domestic product(GDP).

These conclusions also hold when the percentage of substitution from PFAS to F3 attributable to this restriction varies. This ensures the robustness of the results despite the

[5] Although the Oosterhuis and Brouwer study considers policy interventions for PBT and vPvB substances, its findings are considered relevant to PMT-related concerns. While the exposure pathways differ, both regulatory approaches are underpinned by concerns about persistence, uncertain long-term effects, irreversibility, and the need to prevent potentially serious environmental harm before it occurs.

uncertainty regarding the baseline, especially when the most recent progress of substitution (driven by factors such as voluntary substitution, other regulations and regardless of this proposed restriction), or the waste management baseline under current waste legislation (i.e. how users deal with wastes) is uncertain.

As the only currently available and appropriate way of disposing of unused PFAS stock, HTI's capacity constraints are a consideration. Although a "surge" cost of HTI is assumed in the analysis (currently modelled at £3,000/tonne, more than 5 times higher than an estimate of cost from around 2020; this is partly attributed to the surge in demand for HTI due to ongoing POPs regulation disposal requirements), this does not directly address the capacity constraint of HTI facilities. **Under certain specific assumptions, at its peak at the end of 10 years after the restriction enters into force, the demand for HTI will exceed the expected available capacity.** This may make the restriction options involving HTI less cost-effective because costs will be higher than modelled, by increasing storage costs for the unused stock before HTI capacity is available, or by a further surge in prices for HTI. On the contrary, **if sufficient capacity is available and the prices for HTI decrease over time, the restriction options involving HTI will become more cost-effective**. However, given the uncertainties in HTI capacity, demand and how these uncertainties affect HTI prices, it is important to note that the analysis aims to highlight HTI capacity as a consideration, rather than trying to predict HTI pricing dynamics.

4.3.5.5 Limitations and Uncertainty

The analysis is subject to several significant uncertainties, such that the Agency considers the quantitative estimates to be of an order-of-magnitude nature:

- Parameter uncertainty: There are notable data gaps regarding the exact number of sites yet to transition, the actual cost of technical changes for specific GB sector subpopulations, and current stock volumes.

- Extrapolation gaps and baseline uncertainty: Much of the technical cost data and market share information is extrapolated from EU studies (e.g. Wood (2020)), which may not fully reflect the current GB-specific landscape post-2024. It is also unclear how the recently adopted EU restriction will affect the GB market baseline and how users deal with wastes under current waste legislation (waste management baseline). The Agency's analysis of varying the percentage of substitution from PFAS to F3 attributable to this restriction shows that this uncertainty on baseline does not affect the conclusions on cost-effectiveness.

- Benefit monetisation: Due to the non-threshold nature of PFAS risks and the lack of robust toxicological and epidemiological data for thousands of individual PFAS, and to avoid highly speculative and potentially misleading monetised benefits, the benefits of restriction (avoided health and environmental damage) remain purely qualitative or proxy-based, using emissions to proxy risk.

- Unmonetised costs to restriction: Firewater management cost for some sectors (where firewater collection may not be possible) and decontamination of PFAS-containing soil are not monetised, so the full picture of cost-effectiveness has not been presented. This omission is likely to make options involving firewater management and waste/wastewater management (beyond disposal of unused stock) look more cost-effective than they actually are.

4.3.6 Practicality

[For further detail please see Section 6.3.2.1 of the Background Document]

All options set the same transition periods across the various specific sectors/users. For all options, outlined above and in Section 5 of the Background Document, the Agency considers that suitable alternatives to PFAS-containing FFF exist and are available, albeit with necessary substitution caveats (see Section 5.3.4.3.5 of Background Document) as they generally have not been tested on extreme events. For all options, outlined above and in Section 5 of the Background Document, the Agency considers that suitable alternatives to PFAS-containing FFF exist and are available, albeit with necessary substitution caveats (see Section 5.3.4.3.5), as they generally have not been tested on extreme events.

Therefore, in the Agency's view all options are implementable with regard to the availability of alternatives and economic feasibility to transition within the time period derogated for by use.

With regard to enforceability – for all options, regulatory bodies will be able to verify compliance in a number of ways. Sellers of foams could also be audited to check compliance of the foams and labelling aspects of any restriction. For users, this would be principally achieved through audits of purchase documentation for F3 and demonstration that PFAS-containing foam has been replaced. The need for a management plan, and for this to be made available to any enforcing body would also help to be able to document transition, where PFAS FFF are still in use, and the management of any potential emissions and cleaning and maintenance of equipment.

The Agency is of the view that analytical testing of 'end-of-pipe' emissions would be a last resort when the dutyholder was unable to provide any other evidence of transition (as above). In those instances, a threshold, would be required to support enforcement. It has been suggested that the conservative 50 mg/L limit could be used here. Noting it is possible for a dutyholder to have replaced their PFAS-containing foams with F3, and even cleaned their equipment/infrastructure and still potentially be in breach of a 50mg/L threshold (this is known as "rebound" and discussed in Section 3.1.7 of the Background Document and Annex E.11 to the Background Document).

The Agency also acknowledges that enforceability of the restriction in marine uses is complicated by boats/ships being registered in different countries where there may be different or no restrictions on the uses of PFAS. As is acknowledged in ECHA's Background Document, further action involving the IMO – who regulate international shipping, will be required to ensure that restrictions on PFAS on vessels operating internationally are fully functional and enforceable.

Overall, the Agency considers all options to be practical and implementable with regard to the availability of alternatives and economic feasibility, taking into account the transition periods suggested. However, due to the availability and potential capacity of the only acknowledged method to destroy or irreversibly transform PFAS content (HTI) it may be more difficult for dutyholders to comply with RO2a and even more so RO2b due to the need for further HTI capacity for PFAS containing waste, especially if there are peaks in demand at certain times. This could necessitate the storage of unused foam and/or PFAS-containing waste for a period of years until facilities are available.

On enforceability, there are a number of ways that enforcers will be able to verify compliance with the restriction, particularly with the management plan, which is a feature of all the options, providing a good basis to keep records on transition and to show to any enforcing authorities. This is preferable to the use of any enforcement concentration threshold which would only be used in absence of any other auditable records. RO2a and RO2b may be more enforceable with regard to unused foams and/or PFAS-containing waste due to their inclusion in the UK REACH restriction, rather than through reliance on the current regulatory framework for waste management which is not fully joined up (as RO1 does).

It is acknowledged that to aid manageability, all options will require guidance to some extent to help affected dutyholders understand their responsibilities. This will be made available before the relevant responsibilities come into force. Therefore, the Agency concludes that the restriction options are all manageable.

4.3.7 Monitorability

[For further detail please see Section 6.3.2.1 of the Background Document]

For all options, the foam stocks of users could be monitored to understand the constituents (i.e. verify they are PFAS-free). Concentrates could be tested analytically to check for compliance, in addition to audits of purchase documentation. Monitoring could occur on sales from domestic formulators in addition to any potential imports.

As all restriction options place the same limits on use and placing on the market, the Agency considers all options to be monitorable.

Authorities will be able to verify when a user is not in compliance with the restriction requirements. The management plan will require record-keeping requirements on the

continued use of PFAS FFF for uses with transition periods of 5 years and over, which dutyholders are required to provide upon inspection. Compliance visits could take place at both user and formulator/producer sites, in addition to tracking online sales of foam concentrate.

The Agency therefore concludes that all options are monitorable.

Conclusion on Annex 15 criteria

Overall, the ROs are considered to meet the Annex 15 criteria for effectiveness, practicality and monitorability albeit to differing extents. The analysis above is provided to help the decision maker in their consideration of unacceptable risk.

All options have the capacity to reduce the risk from placing on the market and use of PFAS-containing foams. Risk management measures aimed at longer transition uses/sectors are expected to be effective to manage continued emissions, as well as helping with monitoring and compliance of any transition.

It is clear that RO2a and RO2b may be more effective and enforceable at dealing with PFAS-containing waste and /or unused foams, due to the current fragmentation of the current framework on dealing with PFAS emissions at the waste stage that are not under the POPs legislation.

With regard to proportionality, all options are deemed proportionate in comparison to the informally established policy reference point for cost-effectiveness of PBT-type substances regulation, which is also relevant to PMT concerns due to the underpinning concern about persistence, long term effects and irreversibility. However, there are some uncertainties with regard to the proportionality assessment of RO2b given that this does not consider the inability to manage wastewater in some sectors which lessens the potential reduction in emissions from this measure, as well as the lack of inclusion of certain additional PFAS-containing wastes, the costs of which are unable to be monetised due to uncertainty on the amount of the type of waste that is feasible to collect and treat. The Agency is therefore of the view that in terms of cost-effectiveness, transitioning to F3 and requiring appropriate disposal of unused stock achieves the optimal level of emission reduction compared to other combinations of measures. This option (RO2a) results in over 90% emission reduction and, given the uncertainty noted above, this brings the proportionality of additional waste management measures (such as wastewater and PFAS-containing waste beyond unused stocks) into question.

Additionally, the Agency has established that due to low levels of emissions abated for the cost incurred, the continual and ongoing decontamination of equipment and management of rinsewater with additional testing for PFAS is disproportionate.

If high temperature incineration continues to be the only effective method for handling waste, based on the number of current facilities, the capacity in GB to handle PFAS-containing foams and wastes could be limited with demand peaks requiring the need to bid for capacity as well as factors such as planned maintenance, and the possible need to prioritise any legacy PFOS/PFOA waste found. This could affect the implementability of RO2a, but more so RO2b given the additional need to handle PFAS-containing waste via high temperature incineration. It is likely that storage would be required (possibly at cost) until capacity is available.

Although all options will require guidance for dutyholders to comply, RO2b is the most complex with regard to what wastes are required to be treated and what is technically and practically possible.

5 References

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Annex 1: Procedure for adoption of the opinion

On 05 March 2024, the Secretary of State for the Department for Environment, Food and Rural Affairs (Defra), with the agreement of the Scottish Government and the Welsh Government, asked HSE, as the Agency for UK REACH, to prepare an Annex 15 report in respect of a possible restriction on PFAS in FFF.

Table 4: Procedure for the adoption of the opinion

Pre-restriction work:	Regulatory Management Options Analysis (RMOA) on PFAS published by HSE, supported by the Environment Agency. (Published April 2023). The RMOA examined the nature of the risks posed by PFAS and the most appropriate options for management of these risks. PFAS RMOA
Article under which the restriction dossier has been prepared:	Article 69(1)
Risks to be addressed:	This restriction aims to address the risks posed to the environment and human health via the environment that arise from the use of PFAS in FFF.
Date the Registry of Restriction Intentions was updated in accordance with Article 69(5):	05 March 2024
Key information sources used:	ECHA's Annex XV restriction dossier proposing a restriction on PFAS in firefighting foams (March 2022)

	ECHA's Background Document to the Opinion on the Annex XV dossier proposing restrictions on PFAS in firefighting foams (January 2023) Final opinion of ECHA's Risk Assessment and Socioeconomic Assessment committees (RAC and SEAC) on the Annex XV dossier proposing restrictions on PFAS in firefighting foams (June 2023) The text of the implemented EU restriction (Commission Regulation (EU) 2025/1988 of 02 October 2025) Literature search – April 2024 Call for evidence (04 April 2024 – 24 June 2024) Consultation on the Annex 15 Report (18 August 2025 – 18 February 2026) PFAS RMOA (HSE, April 2023) Additional information sources and full list of references can be found in the Background Document.
Call for evidence:	04 April 2024 - 24 June 2024
Information received during the call for evidence:	54 respondents provided information to the call for evidence. 9 confidential and 22 non-confidential attachments were provided by respondents.
Stakeholder Consultation meetings held during the drafting stage:	09 May 2024 – Meeting with Office for Nuclear Regulation

	05 June 2024 – Meeting with JOIFF (International organisation for industrial emergency services training management) 12 June 2024 – Meeting with Civil Aviation Authority 13 June 2024 – Meeting with National Fire Chiefs Council (NFCC) 18 June 2024 – Meeting with Lastfire 20 June 2024 – Meeting with Offshore Energies UK 25 June 2024 – Meeting with Fire Industries Association 27 June 2024 – Meeting with Office of Rail and Road 18 July 2024 – Meeting with Ministry of Defence 14 August 2024 – Meeting with Professor Ian Ross 25 September 2024 – Meeting with Fire Industries Association 08 October 2024 and 08 November 2024 – Meeting with Equinor
Publication of Annex 15 report:	18 August 2025 (registry-of-restriction-intentions.xlsx)
Public Consultation in accordance with Article 69(6):	Start date: 18 August 2025 End date: 18 February 2025
Information received during the public consultation:	35 respondents provided information to the public consultation on the Annex 15 report. 2 confidential and 22 non-confidential

	attachments were also provided by respondents.
Stakeholder Consultation meetings held and meetings with other interested parties/OGDs also attendance at external events during the opinion forming stage:	01 June 2025 – Meeting with Maritime Coastguard Agency 05 November 2025 – Meeting with Essex Fire and rescue service 05 December 2025 – Meeting with Cleveland FRS
Relevant scientific advice sought in accordance with Article 77(1A):	Dossier Review Group 16th July 2025 Challenge Panel meetings held on: 1: 11 June 2026
RISEP Challenge Panel advice on Risk Assessment Opinion:	By Challenge Panel meeting on 11 June 2026: ☒ Support (14) ☐ Support with advisory (number) ☐ Do no support (number)
RISEP Challenge Panel advice on draft Socioeconomic Assessment Opinion:	[Not relevant at this stage] By Challenge Panel meeting on [date]: ☐ Support (number) ☐ Support with advisory (number) ☐ Do no support (number)
Date of formulation of the risk assessment opinion in accordance with Article 70	11 June 2026

Public consultation in accordance with Article 71(1)	Start date: 09 July 2026 End date: 07 September 2026
Challenge Panel advice on final Socioeconomic Assessment Opinion	[Not relevant at this stage] By Challenge Panel meeting on [date]: ☐ Support (number) ☐ Support with advisory (number) ☐ Do no support (number)
Date of formulation of the socioeconomic opinion on accordance with Article 71(2)	[Not relevant at this stage] [date]

Annex 2: List of acronyms

CER	Cost-effectiveness ratio
COMAH	Control of Major Accident Hazards
Defra	Department for Environment, Food and Rural Affairs
ECHA	European Chemicals Agency
HSE	Health and Safety Executive
FFF	Firefighting foams
FRS	Fire rescue services
F3	Fluorine-free foams
GDP	Gross domestic product
HTI	High temperature incineration
ICER	Incremental cost-effectiveness ratio
IMO	International Maritime Organisation
LoD	Limits of detection
LAST	Large Atmospheric Storage Tank
MACC	Marginal abatement cost curve
MACR	Major Accident Control Regulations
MoD	Ministry of Defence
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PFAA	Perfluoroalkyl acid
PFAS	Per- and polyfluoroalkyl substances
PFCA	Perfluoroalkyl acid
PFHxS	Perfluorohexane sulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
PFSA	Perfluoroalkyl sulfonic acids
PMT	Persistent, mobile and toxic
POP	Persistent Organic Pollutant
PV	Present Value
RISEP	REACH Independent Scientific Expert Pool
SVHC	Substances of Very High Concern
TF	Total fluorine
TOF	Total Organic Fluorine
TOP	Total Oxidisable PFAS
vP	very Persistent
vPvB	very Persistent, vey Bioaccumulative
vPvM	very Persistent, very Mobile

WwTP	Wastewater treatment plants

Further information

This publication is available on the HSE website https://www.hse.gov.uk/reach/restrictions.htm in the registry or restriction intentions.

Published by the Health and Safety Executive 07/26.