



# Case study: Per- and poly fluorinated substances (PFAS) in fire-fighting foams

Safer Chemicals Conference 2021

Peter SIMPSON, Denis MOTTET,  
Kalle KIVELA

#SAFERCHEMICALS



# Outline

- Per- and polyfluorinated substances (PFAS) as a 'hot topic' for EU risk management
- Use of PFAS in fire-fighting foams
- ECHA's proposal for a restriction of PFAS in fire-fighting foams
  - REACH Restriction in a nutshell
  - ECHA's approach to developing the restriction proposal
  - Links to the upcoming 'universal' PFAS restriction
  - How restriction proposals are evaluated before decision making

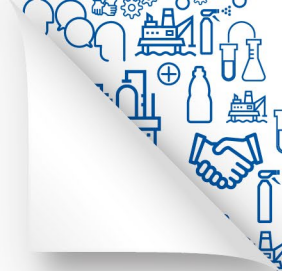
# PFAS as a 'hot topic' for EU risk management





# PFAS as a 'hot topic' for EU risk management – what are PFAS

- PFAS are a large family comprised of thousands of synthetic chemicals
- Diverse and desirable properties
  - For example, thermal stability; surfactant properties; surface-tension modification
- Widely used
  - Industrial, professional and consumer uses
  - Sectors: Aerospace, defence, automotive, textiles, upholstery, leather, carpets, apparel, construction, household products, electronics, food processing, medicines and medical devices, **fire-fighting foams**

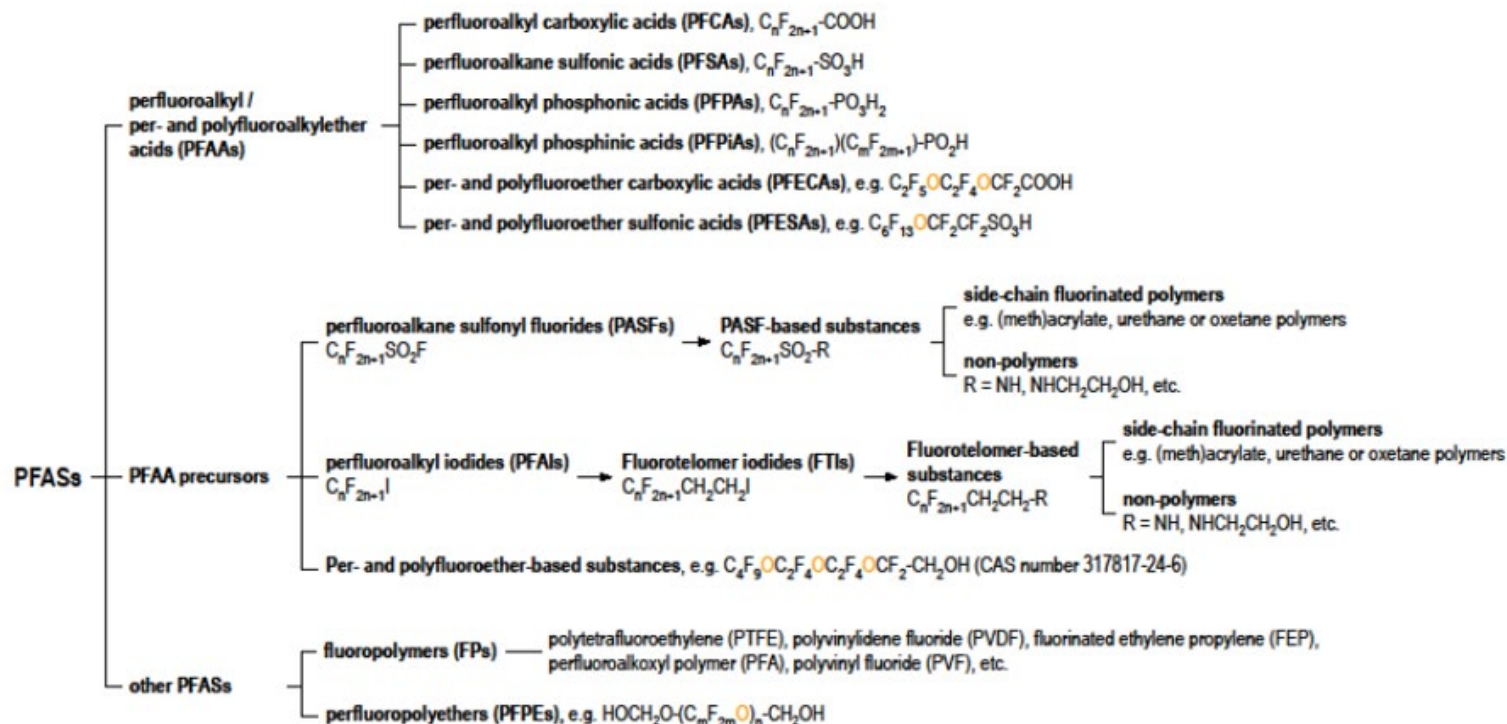


# PFAS as a 'hot topic' for EU risk management – PFAS concern

- PFAS contain (numerous) carbon-fluorine bonds
  - **Very stable** - resist (bio)degradation if released
- Some are highly soluble and mobile (surfactants)
  - can be readily transport once in the environment
  - frequently observed to contaminate groundwater, surface water and soil (atmospheric particles)
- Some bioaccumulate
  - notably 'long chain' PFCAs and PFSA
- Some are persistent, bioaccumulative and toxic (PBT) or very persistent, very bioaccumulative (vPvB)



### a) Commonly recognised per- and polyfluoroalkyl substances (PFASs)



### b) Other highly fluorinated substances that match the definition of PFASs, but have not yet been commonly regarded as PFASs

perfluorinated alkanes ( $C_nF_{2n-2}$ )

perfluorinated alkenes ( $C_nF_{2n}$ ) and their derivatives (e.g.  $[(CF_3)_2CF]_2C=C(CF_3)(OC_6H_4SO_3Na)$ , CAS number 70829-87-7)

perfluoroalkyl alcohols ( $C_nF_{2n-1}OH$ ; e.g.  $(CF_3)_3C-OH$ , CAS number 2378-02-1), perfluoroalkyl ketones (e.g.  $C_nF_{2n-1}C(O)C_mF_{2m+1}$ ) and semi-fluorinated ketones (e.g.  $C_nF_{2n-1}C(O)C_mH_{2m+1}$ )

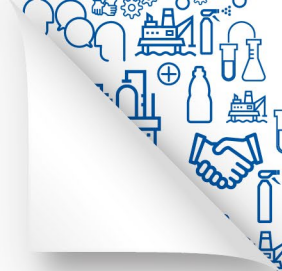
side-chain fluorinated aromatics, e.g.  $C_nF_{2n-1}$ -aromatic rings

some hydrofluorocarbons (HFCs, e.g.  $C_nF_{2n-1}-C_mH_{2m+1}$ ), hydrofluoroethers (HFEs, e.g.  $C_nF_{2n-1}OC_mH_{2m+1}$ ) and hydrofluoroolefins (HFOs, e.g.  $C_nF_{2n-1}-CH=CH_2$ ) that have a perfluoroalkyl chain of certain length



# PFAS as a 'hot topic' for EU risk management – existing regulation

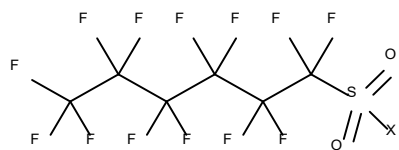
- Some PFAS already subject to (or pending) **restrictions** on manufacture/use under European legislation or global agreements (Stockholm Convention)
  - Perfluoroalkyl sulfonic acids (PFOS; PFHxS)
  - Perfluoroalkyl carboxylic acids (PFOA; C9-C14 PFCAs; PFHxA)
- Some identified as **SVHCs**
  - E.g. HFOP-DA (GenX), PFBS, PFHxS
- Some undergoing **substance evaluation** (CoRAP) or have a **harmonised classification**



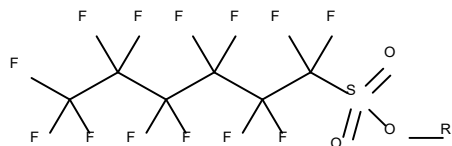
# PFAS as a 'hot topic' for EU risk management – risk management

- Risk management has typically focused on specific individual 'arrowheads' and their 'precursors'
  - **'Arrowheads'** are persistent 'terminal degradation products' with hazardous properties
    - e.g. PFOA, PFHxS
  - **'Precursors'** or **'related-substances'** can transform or degrade to form the 'arrowhead'
  - Therefore, a single restriction can cover many different substances as long as they can degrade/transform to the arrowhead

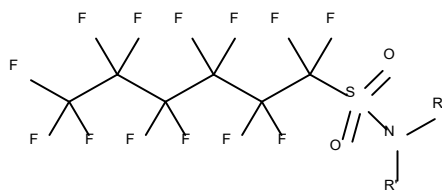




PFHxS sulfonic halides,  
X = F, Cl, Br



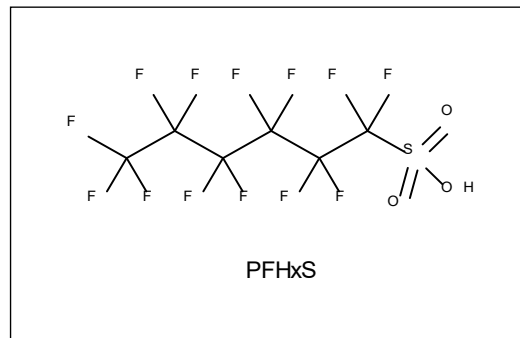
PFHxS sulfonic ester,  
R = alkyl, olefin, aryl



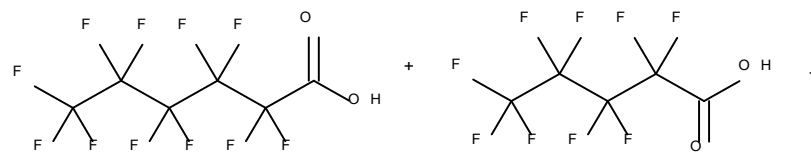
PFHxS sulfonamides,  
R, R' = H, alkyl, olefin, aryl

hydrolysis or  
radical processes

radical  
processes



+



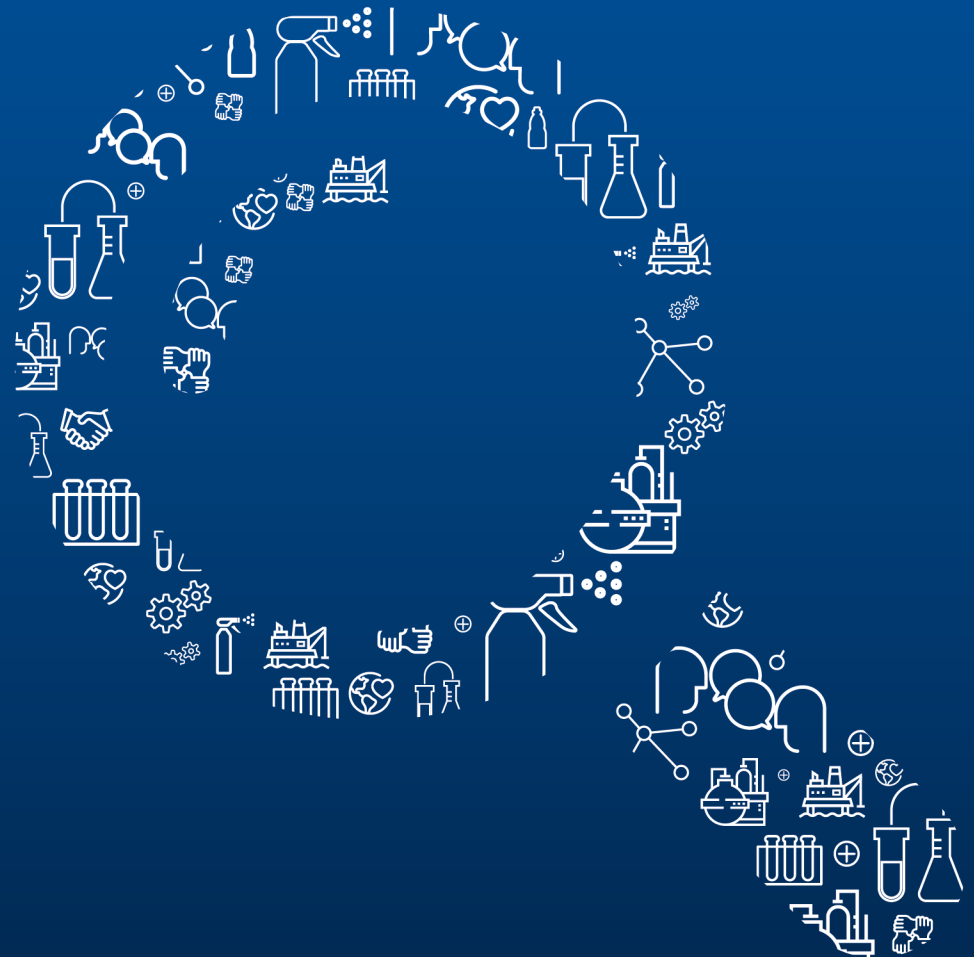
PFCA<sub>s</sub>



# PFAS as a 'hot topic' for EU risk management – risk management

- However, growing consensus that arrowhead approach is an inefficient approach to risk management as would take many years to apply to all applicable arrowheads
- Group-based approach advocated
  - Statements from leading scientists
    - Helsingør Statement - 2014
    - Madrid Statement - 2015
    - Zurich Statement - 2018
  - June 2019 – Council of the European Union – requested the Commission to develop an action plan to eliminate all non-essential uses of PFAS
  - June 2021 - 'Universal' PFAS restriction being prepared by five European countries – Denmark, Germany, Norway, Sweden and The Netherlands.

# PFAS in fire-fighting foams





# Function

- Primary function as a surfactant
- Form a film over the surface of a burning liquid
- Particularly relevant and effective for industrial fires with flammable liquids (Class B fires)

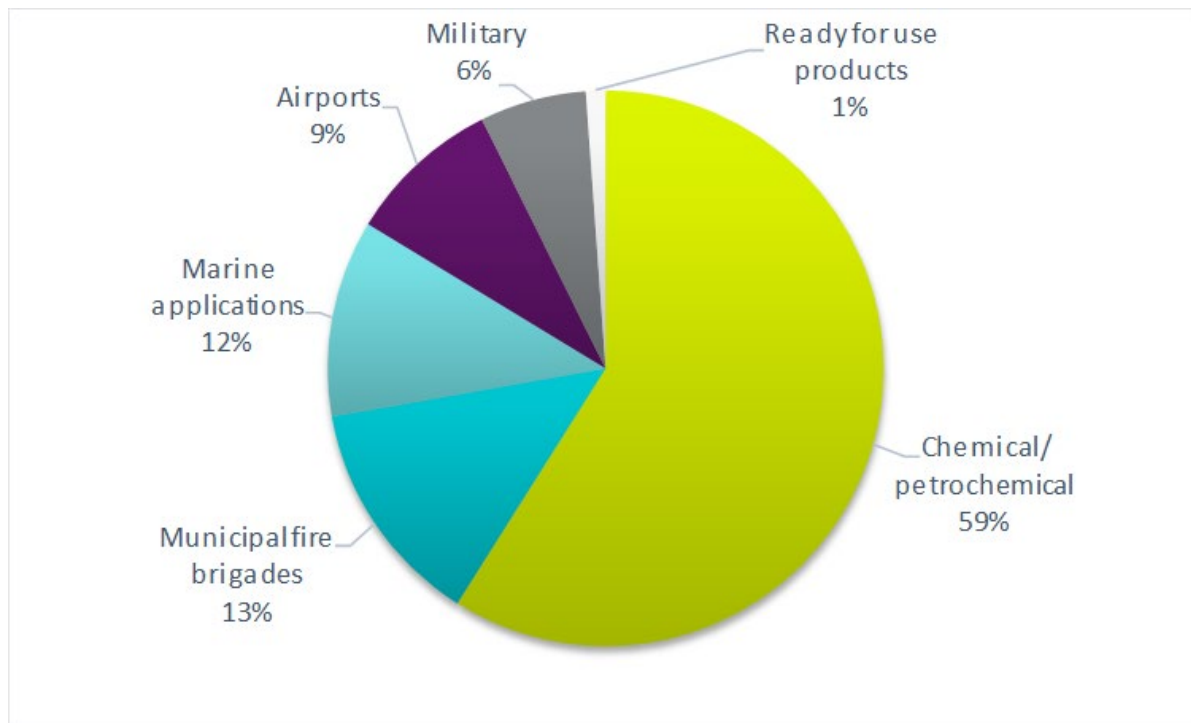
Image: ©iStock.com





## Sectors of use

- Around 20 000 tonnes of PFAS fire-fighting foams are sold in the EU each year
- Equivalent to around 500 tonnes of PFAS



- Oil/(petro)chemical sector is the largest user
- Most sectors have examples of users that have substituted to F-free foams (typically training)

# Analysis of alternatives

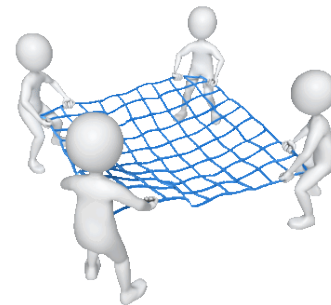
- Alternatives already adopted in many sectors and for training or testing
- Alternatives mostly tested in small-scale standard tests with a limited number of flammable liquids
- Performance testing against large fires or for certain flammable liquids (oil/chemical industry) not yet completed
- Performance of application system and technique is as relevant as the foam itself



Images: ©iStock.com

# REACH restriction in a nutshell

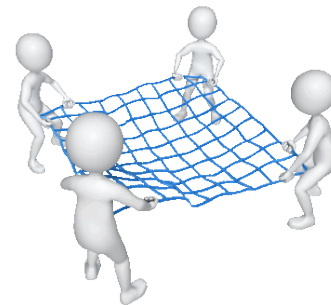




## REACH restrictions

- 'Safety net' for addressing unacceptable union-wide risks to people or the environment
- Where risks have not been addressed by other REACH processes or Community actions
- Can ban the manufacture, placing on the market or use of a substance
- Alternatively, they can set specific conditions for placing on the market or use
  - Specific risk management measures
  - Labelling requirements



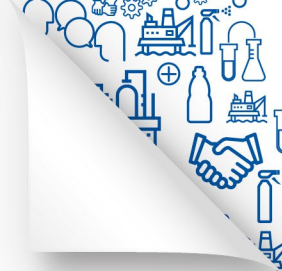


# REACH restrictions

- May be applied to any substance on its own, in a mixture or in an article
- The substance does need to be registered under REACH
  - e.g. polymers, medicines, cosmetics, plant protection products
- The substance does not need to be classified
- No minimum tonnage band
- Union-wide – same requirements apply to the whole EEA from entry into force

# ECHA's restriction proposal for all PFAS in fire-fighting foams





## Background

- 2019-2020: Preliminary studies by ECHA/Commission on use of PFAS fire-fighting foams and their alternatives
- July 2020: Commission requested ECHA to prepare a restriction proposal for **all PFAS** in fire-fighting foams, in cooperation with the five authorities preparing the 'universal' PFAS restriction
  - Action from the Chemical Strategy for Sustainability
- 2020-21: ECHA's scientific committees (RAC and SEAC) evaluate the proposed restriction on PFHxA
  - Fire-fighting foams one of the uses assessed
  - scheduled to be complete in December 2021



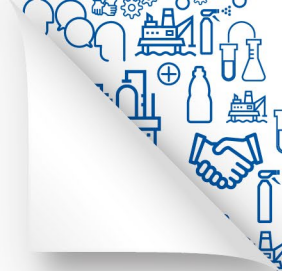
## Approach to grouping

- Restriction covers **all PFAS** fire-fighting foams
- Will mirror the grouping rationale being developed for the 'universal' PFAS restriction
  - $X-(-CF_2-)_n-X'$  with  $n > 1$  and  $X, X'$  not being  $H$  (thus including  $X-CF_3$ )
    - fluorinated substances that contain at least one aliphatic carbon atom that is both saturated and fully fluorinated
  - Avoid potential for regrettable substitution
- Grouping underpinned by a case-by-case risk assessment
  - Microplastics
  - PFHxA



## Restriction options assessed

- Different restriction options developed and assessed considering:
  - How effectively they reduce identified risks (speed and proportionality)
  - How practical they are, also in terms of enforcement
  - How easy they are to monitor
- Series of five restriction scenarios for comparative assessment
- Fire-safety should not be compromised
- Preferred option identified but discarded options also evaluated by RAC/SEAC and could be preferred by the decision-maker



# Restriction options

RO#	Description	Emission reduction profile and possible issues identified
1	Restriction on the <b>placing on the market</b> (use allowed until expiry date of stocks)	Progressive reduction of emissions
2	Restriction on the <b>placing on the market and use</b> (transitional periods per sector of use)	Defined substitution deadlines provide strong incentive for substitution
3	Restriction on the <b>manufacture, placing on the market and use</b> (transitional periods per sector of use)	Exports also banned
4	Restriction on the <b>placing on the market and use</b> (transitional periods per sector of use) with a <b>derogation mechanism</b> for Seveso / defence	Slower reduction of emissions than the other ROs since the largest sector could request derogation for use. Risk management unlikely to be completely effective. Complex enforcement/practicality
5	Restriction for <b>all uses</b> (transitional periods per sector of use) unless <b>risk management measures (RMMs) in place to minimise emissions</b>	Allows substitution if technically and economically feasible and continued use of PFAS foams where not. Only applicable at limited sites being able to implement strictest RMMs. Risk management unlikely to be completely effective

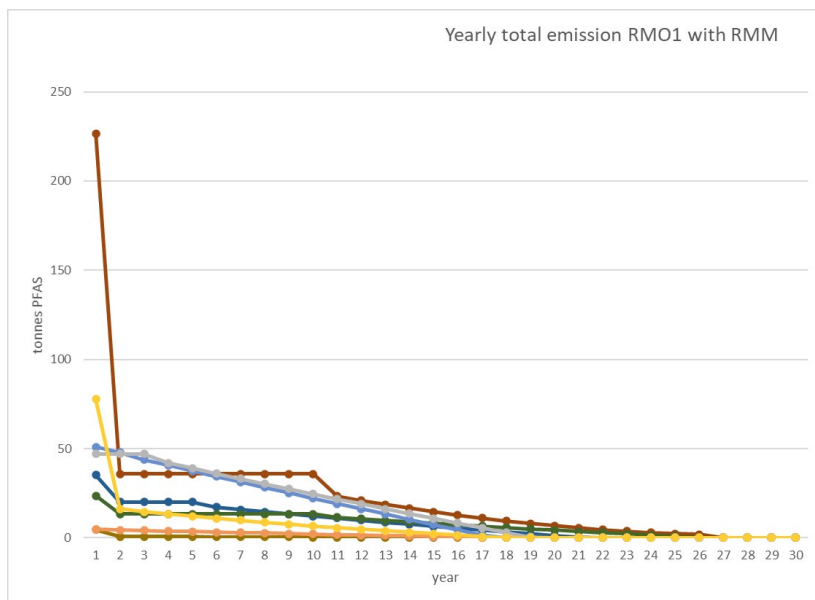
# Approach to exposure assessment

- Focus on emissions (PBT/vPvB approach)
- Two model PFAS used as surrogates for the whole tonnage
- Emissions to environment estimated for each use and life-cycle stage
  - Different transitional periods for restriction modelled

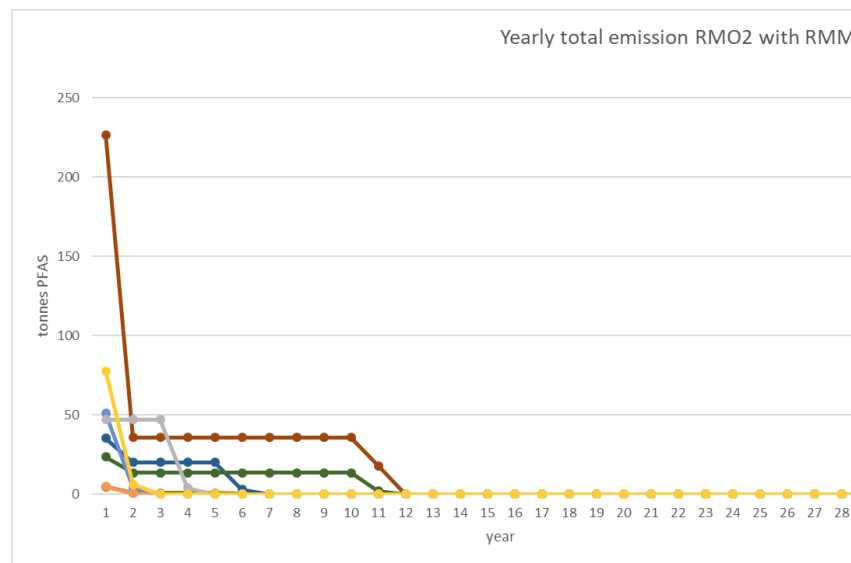
# Approach to exposure assessment

For illustration only – not final

## RMO 1



## RMO 2







# Approach to impact assessment

- Main cost categories covered
  - Cost of using alternative foams (price difference and volumes needed to achieve the same level of fire protection)
  - Cost of technical changes needed to use alternative foams
  - Incineration/disposal of foam: early disposal of foams due to restriction on use (cost for Risk Management Options 2-5) and avoided disposal of expired foams due to substitution (cost savings)
  - Cleaning cost to comply with the proposed concentration threshold
  - Savings from avoided clean-up
  - Producer surplus loss (only for export ban in RMO3)
  - Cost of technical means to contain releases and disposal of PFAS-contaminated water from fire-water run-off during the transition periods
  - Cost of full containment of the foams (only for RMO5)
- Two last categories are related to minimising releases during use



# Approach to impact assessment

- SEAC's PBT/vPvB approach with cost-effectiveness used as a starting point for assessing proportionality (cost of reducing a kg of emissions)
- Qualitative elements (e.g. persistency and mobility) discussed
- Information on (historical) remediation costs that could be avoided in the future to illustrate potential benefits

# Evaluation of restriction proposals



# Evaluation and decision making

- Proposals are evaluated by ECHA's committees for:
  - Risk Assessment (RAC)
  - Socio-Economic Analysis (SEAC)
- Six-month consultation of interested parties
- Evaluation documented in 'opinions'
- Commission and Member States decide on implementing the restriction in REACH Committee
- Scrutiny by Council of the EU and European Parliament





# Thank you!

[peter.simpson@echa.europa.eu](mailto:peter.simpson@echa.europa.eu)

## Follow our news

News: [echa.europa.eu/subscribe](http://echa.europa.eu/subscribe)

Facebook: @EUECHA

LinkedIn: European Chemicals Agency

Twitter: @EU\_ECHA

YouTube: EUchemicals

#SAFERCHEMICALS



#SAFERCHEMICALS

