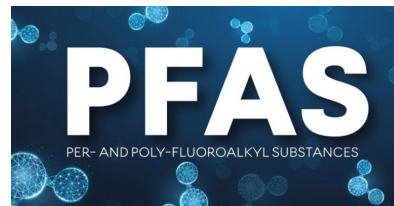


WHAT YOU SHOULD KNOW ABOUT TRIFLUOROACETIC ACID (TFA) AND OTHER ULTRA-SHORT CHAIN PFAS



7th International Congress

Management of Environmental & Health Risks

June 16, 17, 18 & 19, 2026 – Paris



Expertise pollution et
forensie environnementale

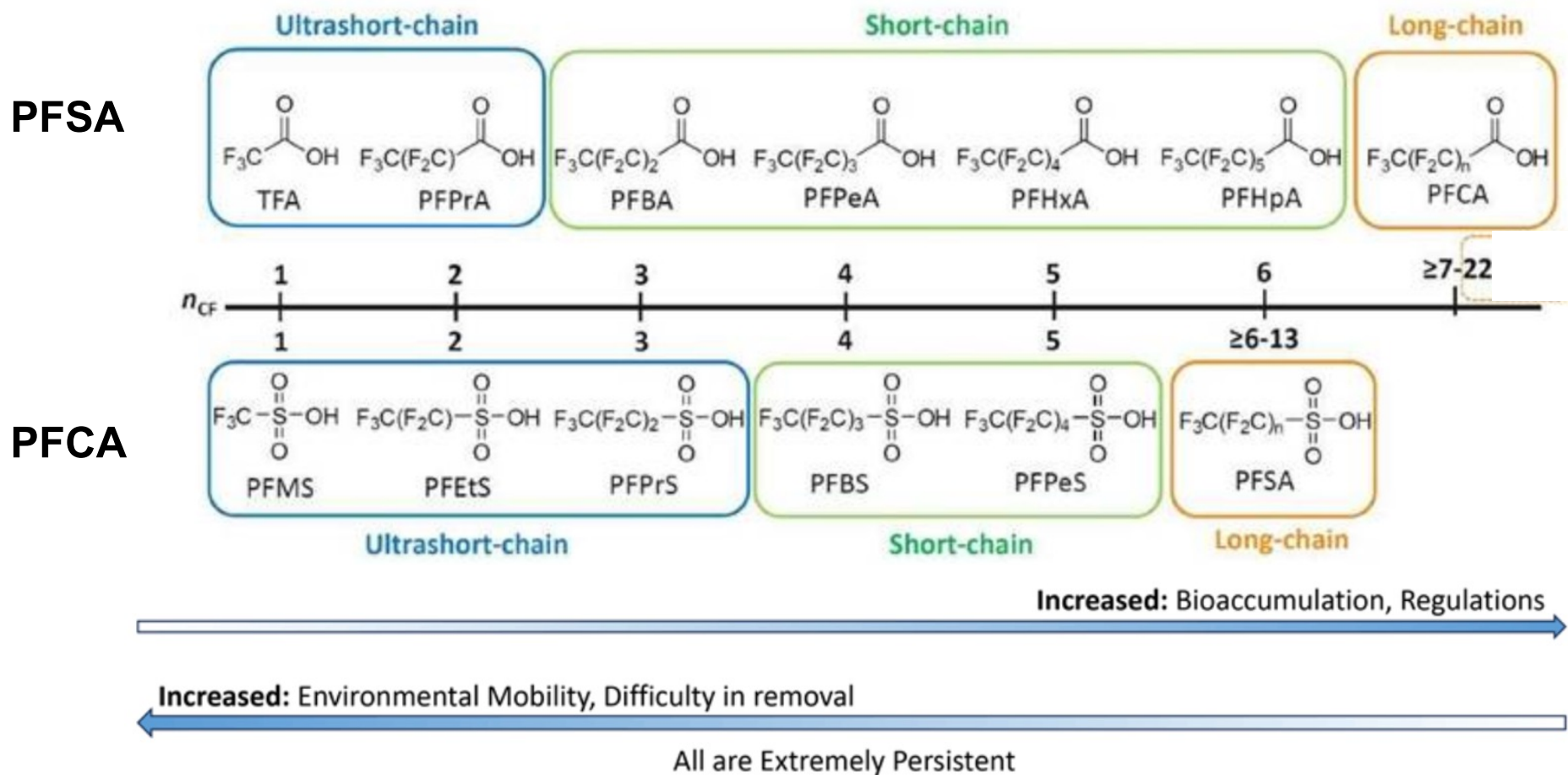
Jacques Martelain (PhD – MBA)
Environmental consultant specializing environmental forensics

DEFINITION

PFAS compounds are often categorized based on their chain length: ultra-short, short, and long

- Ultra-short-chain PFAS (USC-PFAS), the smallest, are typically considered to contain two to three carbon atoms
- Short-chain PFAS have four to six
- And long-chain PFAS typically have seven or more

DEFINITION

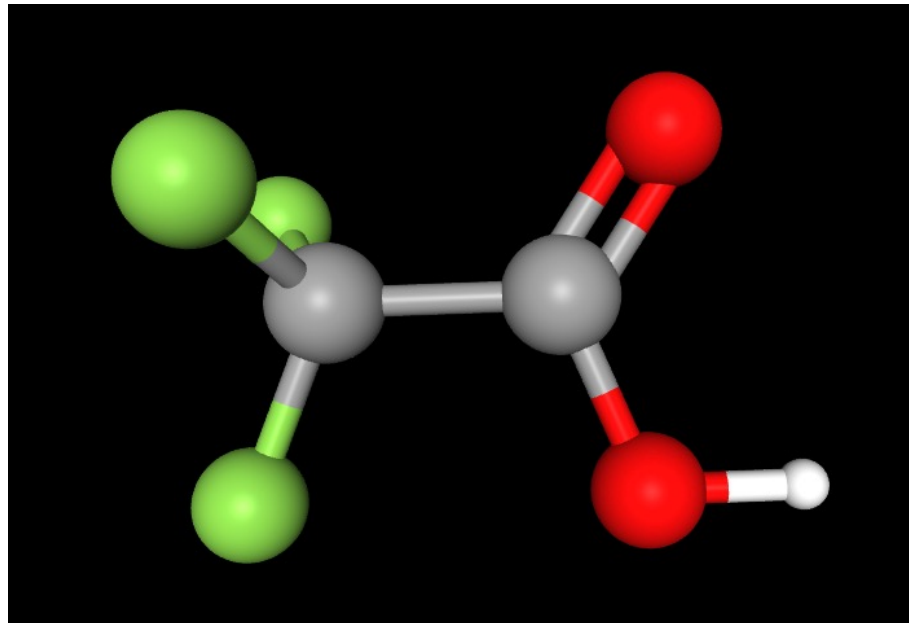


DEFINITION

USC-PFAS Compounds	CAS No
Trifluoroacetic acid (TFA), Perfluoroethanoic acid (PFMeS)	76-05-1
Trifluoromethane sulfonic acid (TFMS), Perfluoromethane sulfonic acid (PFMeS)	1493-13-6
Perfluoroethane sulfonic acid (PFEtS)	354-88-1
Perfluoropropanoic acid (PFPrA)	422-64-0
Perfluoropropane sulfonic acid (PFPrS)	423-41-6
Trifluoromethane sulfinic acid	34642-42-7
Lithium bis(trifluoromethanesulfonyl) imide (LiTFSI)	90076-65-6

TFA

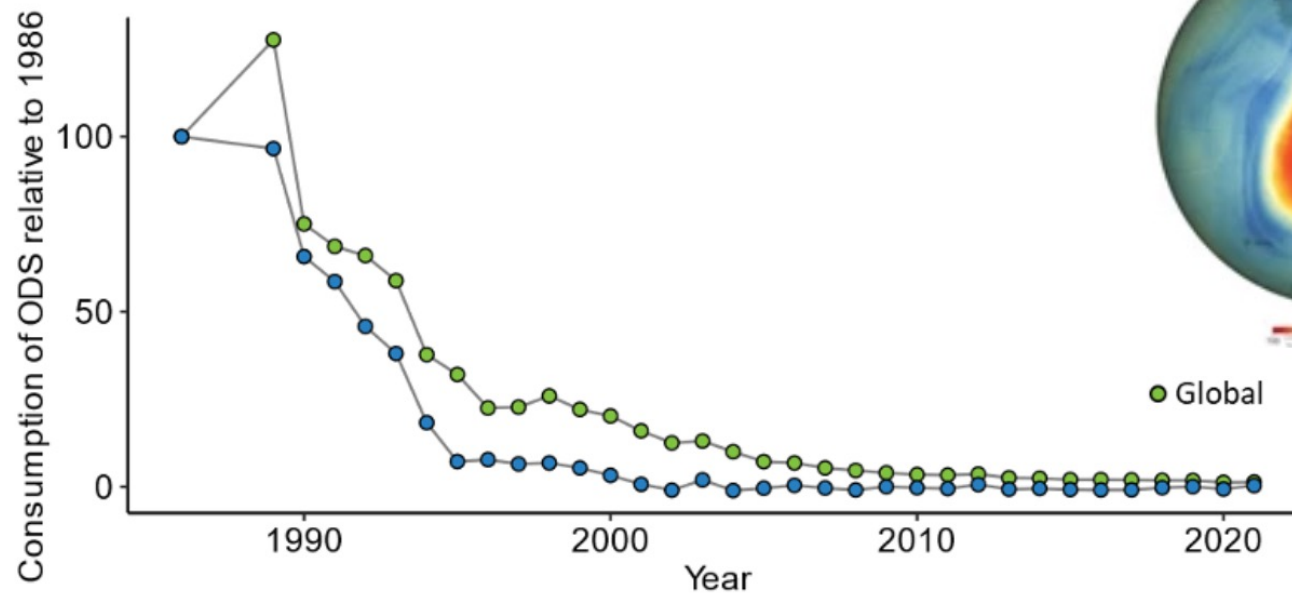
$\text{C}_2\text{HF}_3\text{O}_2$



WHERE DOES TFA COME FROM?

The first source is F-gases

The Montreal protocol saved the planet...



EU and global consumption of ozone depleting substances (ODS, like chlorofluorocarbons) since 1986 due to the Montreal Protocol


WHERE DOES TFA COME FROM?

The Montreal protocol saved the planet... But

- ✓ First generation: Chlorofluorocarbons (CFCs) – Ozone depletion
- ✓ Second generation: Hydrochlorofluorocarbons (HCFCs) – less ozone depleting, but green house gases
- ✓ Third generation: Saturated hydrofluorocarbons (HFCs) => green house gases, mild formation of TFA

HFC-134a ($C_2H_2F_4$)
(1,1,1,2 -Tetrafluoroethane)  Around 15% TFA

- ✓ Fourth generation: F-gases after Kigali amendment (2019): Unsaturated hydrofluoroolefins (HFOs), less global warming potential, increased formation of TFA

μ HFO-1234yf ($C_4H_4F_6$)
(2,3,3,3 - Tetrafluoropropene)  100% TFA
used in almost all new cars in the EU for air conditioning and battery cooling in electric vehicles (prediction 250 folds)

WHERE DOES TFA COME FROM?

The Montreal protocol saved the planet... But

- ✓ According to a recent model (Hart and al.), 335 500 metric tons of TFA came from CFC replacements between 2000 and 2022
- ✓ The model suggests that virtually all TFA measured in Arctic ice cores came from HFCs and HCFCs



Young and De Silva measured yearly levels of three PFAS in ice cores from the Devon Ice Cap in Nunavut, Canada: trifluoroacetic acid (TFA), perfluorobutanoic acid (PFBA), and perfluoropropionic acid (PFPrA) and shown that levels of all three compounds have been increasing since 1990

WHERE DOES TFA COME FROM?

The second source is herbicide and fungicide precursors

Almost 30 plant active ingredients in plant protection products are currently approved in Europe that contain at least one CF_3 -group in their molecular structure and thus have the potential to degrade into TFA.

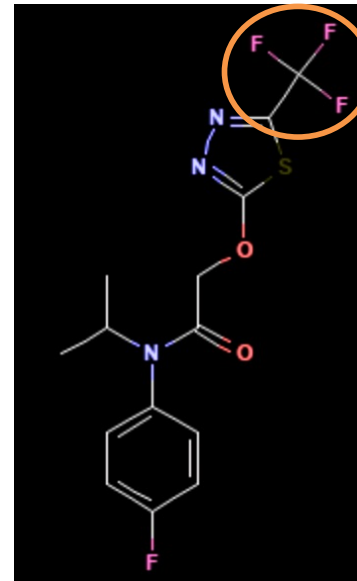
In 2023, in Zwitterland, more than 30 tons of these plant protection products were applied.

WHERE DOES TFA COME FROM?

The second source is herbicide and fungicide precursors

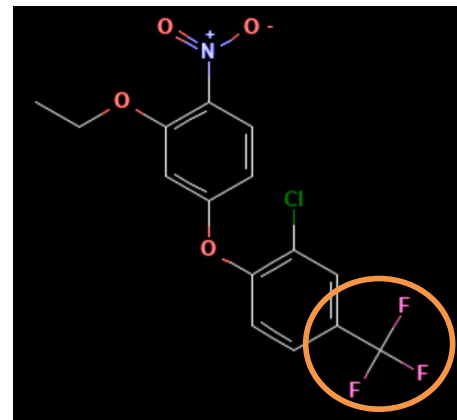
In Europe

- Flufenacet



Joerss et al. (2024)
Environment
International, 193,
109061.

- Oxyfluorfen

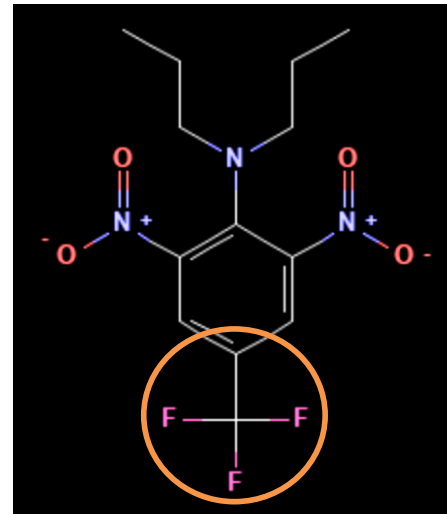


WHERE DOES TFA COME FROM?

The second source is herbicide and fungicide precursors

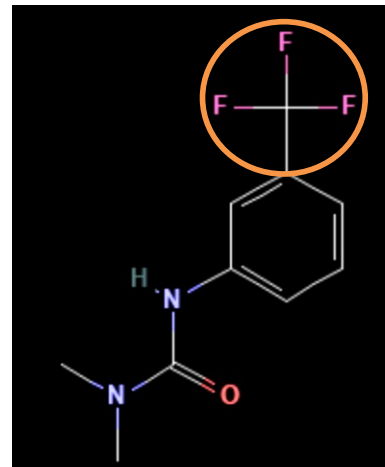
In the United States

- Trifluralin



Joerss et al. (2024)
Environment
International, 193,
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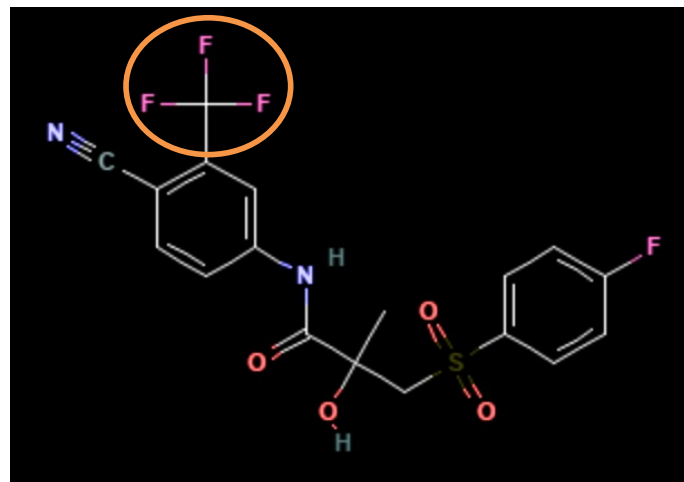
- Fluometuron



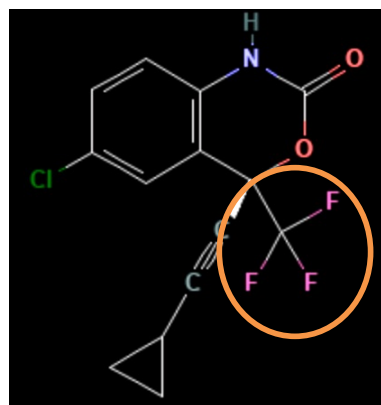
WHERE DOES TFA COME FROM?

The third source is pharmaceuticals

- Bicalutamide
(Prostate cancer)



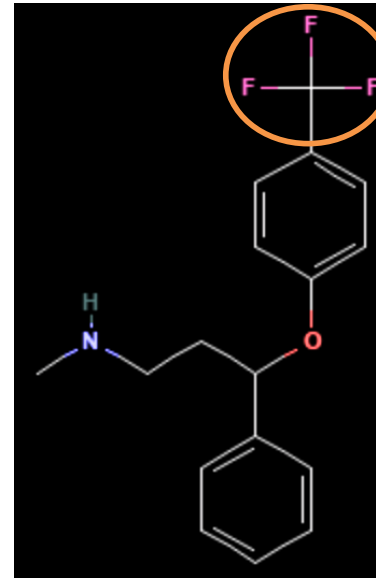
- Efavirenz
(HIV / AIDS)



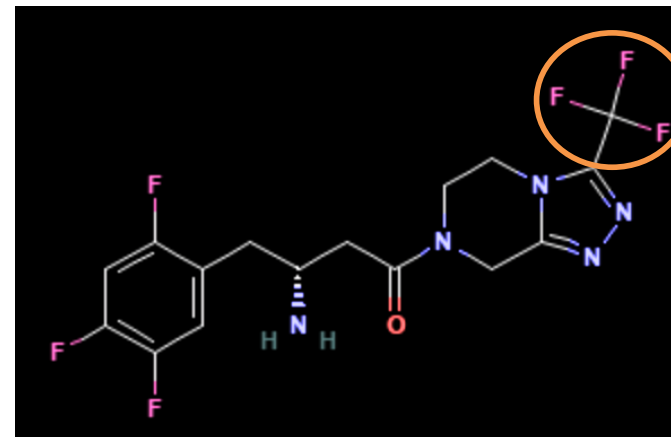
WHERE DOES TFA COME FROM?

The third source is pharmaceuticals

- Fluoxetine (Prozac)
(Anti depressant)



- Sitagliptin
(Anti diabetic))



WHERE DOES TFA COME FROM?

The fourth source is release from PFAS production

TFA is also used in the chemical industry, including as a solvent in the manufacture of medical and cosmetic raw materials

EU production of TFA: 100 to 1000 tons per year

WHERE DOES TFA COME FROM?

The fourth source is release from PFAS production

TFA releases during production: 7 500 µg/l in river
Arias near the site of Solvay in Salindres (Gard - F)



WHERE DOES TFA COME FROM?

TFA IS ACCUMULATING EVERYWHERE

In precipitation

In Switzerland: 0.6 µg/l (= average of 0.6 kg/km²/year = 25 tons per year)

In groundwater

Concentrations are around 100 to 1 000 times higher than concentrations of other PFASs that have been detected in groundwater to date

WHERE DOES TFA COME FROM? TFA IS ACCUMULATING EVERYWHERE

In tap-water:

In Europe: TFA found in 94% of tap-water samples and 63% of bottled mineral and spring water samples

In beer: 6.1 µg/l (median)

In orange juice: 34 µg/l (average)

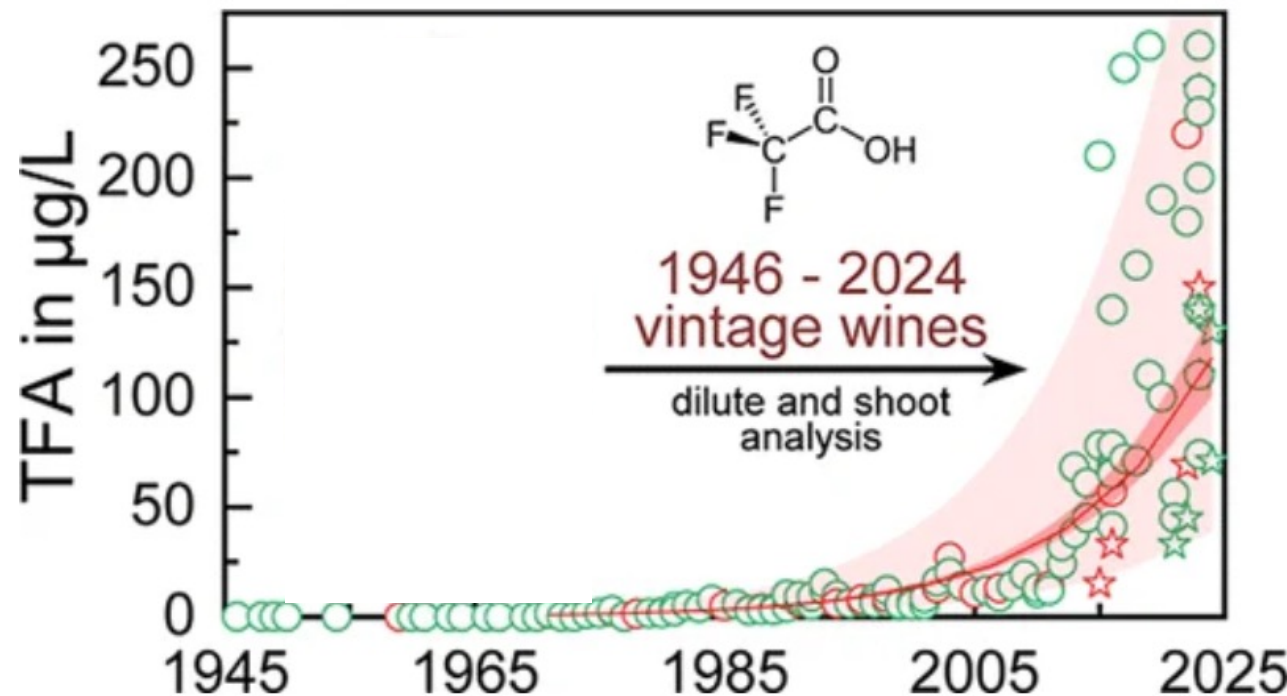
In cereal products: 58 µg/kg dm (median) with a peak value at 280 µg/kg dw

In people blood

...

WHERE DOES TFA COME FROM? TFA IS ACCUMULATING EVERYWHERE

In wine



Tracking
Trifluoroacetate
(TFA) through Time:
A 78-Year Record
from Archived Wines

- ✓ There was no detectable TFA in wine pre-1970
- ✓ Between 1970 and 2010 there was a moderate increase in TFA
- ✓ Since 2010, TFA concentrations have increased rapidly

THE COSTS OF PFAS REMOVAL INCREASES IT SPREADS

- ✓ Health costs by 2050 – €438 billion (European Commission, 2025)
- ✓ Remediation Legacy PFAS – only treat legacy PFAS (e.g. PFOS) and assume emissions stopped
€38 - 100 billion over 20 years
- ✓ Emerging Scenario for TFA – short chain PFAS and TFA continue to be emitted: €2000 billion over 20 years

TOXICITY

RIVM (2022)

Chronic rat toxicity (feeding)

Dose response: Male liver weight vs dose

Relevant potency factor: TFA is 0.002 x toxic as PFOA

Corresponds to a water threshold value of 2.2 µg/l

ECHA REACH Dossier (2024)

Rabbits

Embryo-fetal developmental toxicity <180 mg/kg/day

Since June 10th, the ECHA Risk assessment Committee made a proposal for the harmonized classification of TFA as:

- Toxic for reproduction, Category 1B
- Persistent, mobile and toxic
- Very persistent and very mobile

CONCLUSION



THANK YOU



Jacques Martelain

j.martelain@orange.fr

+ 33 6 72 73 53 40 🇫🇷

+ 41 78 842 34 11 🇨🇭