

INCEPTION REPORT

Project name	PFAS-ANALYSIS IN THE CONTEXT OF A REACH RESTRICTION
Project no.	Case Number 2021/2019
Document type	Inception report
Version	1
Date	11/05/2021
Prepared by	
Checked by	
Approved by	

CONTENTS

1.	Introduction and aims of this inception report	2
2.	Search strategy for PFAS analysis in various matrices	3
2.1	Information sources	3
2.2	In/exclusion criteria	7
2.3	Search string	7
3.	Documentation Sheet	10

1. Introduction and aims of this inception report

The purpose of the present project is to collect and compile information on analytical methods for PFAS in such a way that the needs of a restriction proposal are covered.

This should cover all types of PFASs in the scope of the universal restriction (including small molecule PFASs, ionic and neutral PFASs, fluorotelomer alcohols and perfluoroalkyl ethers). For fluoropolymers and side-chain fluorinated polymers analytical methods needs to be discussed as well.

In general all methods for the analysis of PFAS in mixtures and articles necessary for the enforcement of the restriction should be considered. Total fluorine methods are also of interest and will be included. In addition, analytical methods for human and environmental samples need to be considered in order to be able to evaluate the regulation's monitorability. A specific attention should be given to analytical standard methods.

As agreed in the kick-off meeting (sent in an individual mail), before we start the actual work, we would like to collect the input and/or feedback from the involved countries. This includes in particular feedback/input on

- Information sources
- In/exclusion criteria
- Search string
- Documentation sheet

In the following key aspects related to these points are addressed.

Please note, this commenting round should help to involve all expectations from authority's side from the beginning and should avoid adaptations when the literature search has started.

Please feel free to share any information concerning the above-named points with us. You can comment on this report or send a mail to [REDACTED]

2. Search strategy for PFAS analysis in various matrices

As introduced in the Kick-off meeting, the strategy for the comprehensive literature search on PFAS analysis methods in various matrices is explained in detail in the following. We would like to invite every representative of the participating countries to give input (e.g. on the search terms concerning the respective PFAS usages and expected matrices).

Again, we would like to invite you to share any information concerning the search strategy with us. You can comment on this report or send a mail to [REDACTED]

2.1 Information sources

Ramboll/VITO plans to consult the following information sources:

- Screening of available information within the group and known publications like Gluege et al.
- Agencies (incl. work by ECHA (C9-C14, PFHxA, ADONA ...) and Stockholm Convention)
- Scientific peer-reviewed literature (Pubmed, EuroPMC)
- Standardization bodies (incl. Draft standard methods if available)
- Eco-labels and respective required analytical methods (Grüner Knopf, Blue Angel, Nordic Swan)
- Projects (HBM4EU, NORMAN...)
- Targeted Stakeholders

Please note, that [REDACTED] [REDACTED] already shared information with the project team. Please see [Table 1](#) for this.

Concerning the individual PFAS applications, we already highlighted some questions in the respective section please see [Table 5](#).

Table 1: Shared information from

Articles	Year	Title	Source
Al Amin et al.	2020	Recent advances in the analysis of per- and polyfluoroalkyl substances (PFAS)—A review.	https://www.sciencedirect.com/science/article/pii/S2352186420303461
Dodds et al.	2020	Rapid Characterization of Per- And Polyfluoroalkyl Substances (PFAS) by Ion Mobility Spectrometry-Mass Spectrometry (IMS-MS)	https://pubs.acs.org/doi/10.1021/acs.analchem.9b05364
Lai et al.	2019	A critical review on passive sampling in air and water for per- and polyfluoroalkyl substances (PFASs)	https://www.sciencedirect.com/science/article/pii/S0165993618304163
Lorenzo et al.	2018	Analytical challenges to determine emerging persistent organic pollutants in aquatic ecosystems	https://www.sciencedirect.com/science/article/pii/S0165993618300542
McDonough et al.	2019	Measuring Total PFASs in Water: The Tradeoff between Selectivity and Inclusivity	https://www.sciencedirect.com/science/article/pii/S2468584418300515
Montes et al.	2017	Screening for Polar Chemicals in Water by Trifunctional Mixed-Mode Liquid Chromatography-High Resolution Mass Spectrometry	https://pubs.acs.org/doi/10.1021/acs.est.6b05135
Nakayama et al.	2019	Worldwide trends in tracing poly- and perfluoroalkyl substances (PFAS) in the environment	https://www.sciencedirect.com/science/article/pii/S0165993618306605
Brase et al.	2021	Legacy and Emerging Per- and Polyfluoroalkyl Substances: Analytical Techniques, Environmental Fate, and Health Effects	https://pubmed.ncbi.nlm.nih.gov/33498193/
De Silva et al.	2021	PFAS Exposure Pathways for Humans and Wildlife: A Synthesis of Current Knowledge and Key Gaps in Understanding	https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4935
Göckener et al.	2021	Exploring Unknown Per-and Polyfluoroalkyl Substances in the German Environment –the Total Oxidizable Precursor Assay as Helpful Tool in Research and Regulation	https://www.sciencedirect.com/science/article/pii/S0048969721018957
Koch et al.	2020	Towards a comprehensive analytical workflow for the chemical characterisation of organofluorine in consumer products and environmental samples	https://www.sciencedirect.com/science/article/pii/S0165993618306356
Menger et al.	2021	Sensors for detecting per- and polyfluoroalkyl substances (PFAS): A critical review of development challenges, current sensors, and commercialization obstacles	https://www.sciencedirect.com/science/article/pii/S1385894721007245
Munoz et al.	2019	Analysis of F-53B, Gen-X, ADONA, and emerging fluoroalkylether substances in environmental and biomonitoring samples: A review	https://www.sciencedirect.com/science/article/pii/S2214158819300145
Nakayama et al.	2019	Worldwide trends in tracing poly- and perfluoroalkyl substances(PFAS) in the environment	https://www.sciencedirect.com/science/article/pii/S0165993618306605

Articles	Year	Title	Source
Nikiforov	2021	Hydrolysis of FTOH precursors, a simple method to account for some of the unknown PFAS	https://www.sciencedirect.com/science/article/pii/S0045653521005130
Kaiser et al.	2010	Understanding Potential Exposure Sources of Perfluorinated Carboxylic Acids in the Workplace	https://academic.oup.com/annweh/article/54/8/915/170331
Nilsson et al.	2013	Professional ski waxers' exposure to PFAS and aerosol concentrations in gas phase and different particle size fractions	https://pubs.rsc.org/en/content/articlelanding/2013/em/c3em30739e#!divAbstract
Freberg et al.	2014	Occupational Exposure Assessment of Airborne Chemical Contaminants Among Professional Ski Waxers	https://academic.oup.com/annweh/article/58/5/601/215881
Gluege et al. (on PFAS applications)	2020	An overview of the uses of per- and polyfluoroalkyl substances (PFAS)	https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract
Reports			
Ventia, Alga, NMI, ALS, Eurofins	2019	Improving Measurement Reliability of the PFAS TOP Assay	https://www.ventia.com/ckeditor_assets/attachments/281/ALGA_R_D_Report_Final.pdf
Washington State	2020	Per-and Polyfluoroalkyl Substances Draft Chemical Action Plan (Appendix 2)	https://apps.ecology.wa.gov/publications/documents/2004035.pdf
Schultes, Stockholm University	2019	Fluorine mass balance in wildlife and consumer products: How much organofluorine are we missing? (PhD-thesis)	http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1300861&dsw_d=3092
US EPA	2020	Technical Brief: PFAS, Methods and guidance for sampling and analyzing water and other environmental media	https://www.epa.gov/sites/production/files/2020-01/documents/pfas_methods-sampling_tech_brief_7jan2020-update.pdf
EU Commission	2020	Workshop and Workshop Report on PFAS Monitoring	http://api.kwrwater.nl/uploads/2020/07/Umweltbundesamt-Final-Workshop-Report-(Workshop-and-workshop-report-on-PFAS-monitoring)-van-Keer-Hohenblum-B-en-et-al-Conference-Center-Albert-Borschette-Brussels-13-14-January-2020.pdf
KEMI	2021	Interlaboratory Comparison of Extractable Organofluorine (EOF)	https://www.kemi.se/download/18.f1b904217860f8d6f035d/1616769307985/PM-5-21-Interlaboratory-Comparison-of-Extractable-Organofluorine-EOF.pdf
Workshops and webinars			
Agilent	27.04.2021	Sensitive Techniques for Targeted PFAS Analysis in Water	https://event.on24.com/eventRegistration/EventLobbyServlet?target=reg20.isp&referrer=8&eventid=2816564&sessionid=1&key=61B1C31E328FDD0E732A190B59158E48&reqTag=1799055&V2=false&sourcepage=register

Ramboll -

Articles	Year	Title	Source
BAM	01.09.2021	Advancements of Analytical Techniques for Per- and Polyfluoroalkyl Substances (PFAS)	https://www.bam.de/Content/EN/Events/2021/2021-09-01-pfas.html
NILU	12.05.2021	PERFORCE3 Webinar. The total oxidizable precursor assay (TOPA): From research to regulation	https://perforce3-tn.eu/events/perforce3-webinar-topa/
ECHA , info and guidances			
ECHA, Forum	2016/2020	Compendium on analytical methods to enforce restrictions published	https://echa.europa.eu/view-article/-/journal_content/title/compendium-on-analytical-methods-to-enforce-restrictions-published
Previous PFAS restriction proposals that may contain relevant information on analytical methods			
PFOA	Report and annexes		https://www.echa.europa.eu/documents/10162/e40425c6-590f-8df7-2cd9-0eef79527685
C9-C14 PFCA	Report and annexes		https://www.echa.europa.eu/documents/10162/02d5672d-9123-8a8c-5898-ac68f81e5a72
PFHxS	Report and annexes		https://www.echa.europa.eu/documents/10162/b4ad0be9-7a1c-e2b1-6f27-a6727c94e74b
PFHxA	Report		https://www.echa.europa.eu/documents/10162/c4e04484-c989-733d-33ed-0f023e2a200e
	Annexes		https://www.echa.europa.eu/documents/10162/cc64c9fd-0987-854e-7ac7-cdf829b938dc

2.2 In/exclusion criteria of the literature search

In [Table 2](#) the in- and exclusion criteria for the search are shown. In addition to the shown criteria, Ramboll plans, in the case that too many hits are found (>500-1000), to reduce the search to the title and abstracts of the respective publications. Please feel free to comment.

Table 2: In/Exclusion criteria

Inclusion criteria	Exclusion criteria
Any publication date Data found in PubMed/EuroPMC	Any other lanquaqe than English Review articles (whereby relevant individual publications will be extracted) Publications in which the occurrence of PFAS in the matrices is reported but no relevant measurement technique described

2.3 Search string

As agreed in the kick-off meeting the search strings are divided into three parts, that will be connected logically:

- 1. Synonyms covering PFAS
- 2. Synonyms covering analytical measurement
- 3. Synonyms terms covering the matrix

With this relatively focused search, we are confident that we will reach an adequate balance between relevant papers and non-relevant papers.

Please see here an example:

PFAS OR PFCs OR PFAA* OR PFOS OR PFOA OR perfluor* OR polyfluor**
AND
Analy OR test* OR standard* OR method* OR determin* OR investing**
AND
Textil OR leather OR apparel OR upholstery OR garment OR fabric OR clothing OR "outdoor" OR "impregnation"*

In the following, the three-parts of the search string will be highlighted in more detail. Please see [Table 3](#), [Table 4](#), and [Table 5](#).

[Table 3](#) shows the synonyms covering PFAS (and any substances falling under the current restriction proposal). A majority of the synonyms have been copied from a proposal by the BfR (document name: Search strategy proposal_20April2021.docx). To make sure, that we cover also CF2/CF3 substances, we would like to propose including also the search term "fluorin*", which captures also these substance identities.

Table 3: Synonyms covering PFAS

PFAS* OR PFCs OR PFAA* OR PFOS OR PFOA OR perfluor* OR polyfluor* OR organofluor* OR fluorocarb* OR fluoropolymer* OR "fluorinated polymer*" OR fluoroelastomer* OR fluorotelomer* OR "fluorinated telomer*" OR fluoro-telomer* OR Fluorosurfactant* OR fluorinated surfactant* OR "Fluorinated gas*" OR "Fluorinated greenhouse gas*" OR F-gas OR hydrofluorocarbon* OR hydrofluoroolefin* OR hydrofluoroether* OR chlorofluorocarbon* OR hydrofluorocarbon* OR ADONA OR GenX OR flourin*

Table 4 shows the synonyms covering the analytical measurement.

Table 4: Synonyms covering the analytical measurement

Analysis* OR analytic* OR test* OR standard* OR method* OR determin* OR investing*

Table 5 shows the synonym terms covering the individual matrices. With the aim to find relevant search terms, the project team consulted Gluege et al., 2020 for relevant usages and/or functions within the PFAS applications (mainly the electronic supplemental data, see [here](#)).

Table 5: Synonym terms covering the matrix

Application	Country	Synonyms (orientated to the reported usages/functions in Gluege et al., 2020)
Textiles, leather and apparel and textile related products	SE, DK	Textil* OR leather OR apparel OR upholstery OR garment OR fabric OR clothing OR "outdoor" OR "impregnation" OR sportswear OR clothing OR "work wear" OR workwear OR "personal protection equipment" OR PPE OR gown OR carpet OR "technical textile"
Packaging material, FCM & food & feed processing equipment	NL	Packaging OR FCM OR "food contact" OR "food processing" OR "feed processing" OR "food production" OR "feed production" OR foodstuff OR "moisture barrier" OR "anti-stick" OR Teflon OR nonstick OR "non-stick" OR cookware OR "cook ware" OR "bake ware" OR bakeware OR "baking ware"
Consumer mixtures	DE	"Consumer product" OR "consumer article" OR "cleaning product" OR dishwash* OR wash OR cleaner OR "cleaning solution*" OR polish OR paint OR coating OR household
Lubricants and construction products	DK	Lubricant* OR grease* OR lube OR "Architectural membrane*" OR "membrane structure" OR cement OR wire OR cable OR gasket* OR seal OR hose* OR tube OR pipe OR construction OR building OR adhesive OR sealant OR caulk OR paints OR coatings OR varnish*
Cosmetics	SE, DK	Cosmetic* OR "make-up" OR "make up" OR makeup OR "Personal care" OR hair OR beauty OR "anti-aging" OR "anti-frizz" OR "bar soap" OR cream OR foundation OR blush OR highlighter OR "body lotion" OR "body cream" OR "body oil" OR "brow products" OR concealer OR corrector OR cream OR lotion OR "cuticle treatment" OR "eye cream" OR eyeshadow OR "eye pencil" OR eyeliner OR "face cream" OR "facial cleanser" OR "hair creams" and rinses OR conditioner OR "hair spray" OR mousse OR shampoo OR "hand sanitizer" OR highlighter OR "lip balm" OR "lip stick" OR "lip gloss" OR "lip liner" OR "manicure products"

Commented [A1]: Question to SE and DK: We included here also technical textiles like PPE is this in the scope?

Please feel free to add also more search terms if needed.

Commented [A2]: Question to NL: We included also cookware. Is that in the scope?

Please feel free to add also more search terms if needed.

Commented [A3]: Question to DE:

"Consumer mixtures" is likely to encompass a variety of PFAS application. We would include here all PFAS-containing mixtures that can be purchased by consumers (for example cleaning. Leaving apart:
Cosmetics
Ski wax
Textile treatment products for consumers

As they are covered within other PFAS applications.

Are articles to be excluded? (e.g. PFAS are known to be used in sport and music equipment), Gluege et al

Please feel free to add also more search terms if needed.

		OR "makeup remover" OR mask OR mascara OR lashes OR moisturer OR nail polish OR nail strenghtener OR "nail treatment" OR powder OR primer OR fixer OR scrub OR peeling OR shaving cream OR shaving foam OR sunscreen
Production of PFAS, including polymers	NL	"Polymer production" OR telomeri?ation OR polymeri?ation OR "electrochemical fluorination" OR emulsifier OR emulgent
Chrome plating	DE	Plating OR "suppressant" OR "chromium" OR chrome
Treatment of skis	NO	"ski*" OR snowboard* OR snowmobile OR toboggan OR sled OR "Glide wax"
Transportation, Automotive, Aircraft, Space and Ships	DE	Transportat* OR aircraft OR airplane OR aeroplane OR aerospace OR ship OR space OR "jet engine" OR automo* OR "car" OR windshield OR "wiper fluid" OR "motor oil" OR "air bag" OR "car interior" OR "dash panel" OR "safety restraint system" OR "steering system" OR brake OR "hydraulic fluid" OR gyroscope* OR "Thermal control" OR boat OR watercraft
Oil, gas and mining industry	NO	"ore leaching" OR "ore floating" OR "drilling" OR "oil production" OR "gas production" OR "oil transport" OR "gas transport" OR mining OR "oil sector" OR "gas sector" OR "mining sector" OR "oil industry" OR "gas industry" OR "mining industry"
Medical devices, pharmaceuticals	NL	"Medical device" OR "medicinal device" OR defibrillator OR pacemaker OR "high dielectric insulator" OR "charge-coupled device" OR "contrast agent" OR "x-ray" OR "eye drop" OR eyedrop OR "contact lens*" OR pharmaceutical* OR therapeutic* OR retinal OR Dialysis OR catheter OR stent* OR needle* OR "Oxygen carrier" OR "artificial blood" OR angioplast* OR dental OR respirator*
F-gases and refrigerants including blowing agents	NO, DK	"air condition*" OR refrigerant* OR refrigerat* OR "heat transfer" OR blowing OR propellant OR "F-gas" OR "greenhouse gas*" OR "HFCs"
PFAS in electric and electronic equipment including semiconductors	DK, NL	Electric* OR electronic* OR semiconductor OR "semi-conductor" OR "semi conductor" OR "printed circuit boards" OR "loudspeaker*" OR transductor OR camera OR phone OR printer OR scanner OR satellite OR "radar system*" OR "hard drive" OR "cooling liquid" OR "evaporative cooling" OR "brine cooling" OR "direct contact cooling" OR "total immersion cooling" OR "carrier fluid" OR Photolithograph*
Flame retardants & resins and industrial applications	?????	„Flame retard*" OR resin OR solvent OR curing OR "solar collector" OR "wind mill*" OR windmill OR photovolt* OR battery
Waste treatment PFAS articles & industrial waste	NL	Waste OR landfill OR leachate OR incinerat* OR recycling OR dispos*

Commented [A4]: Question to NL:

Also other Polymers than fluropolymers?

Gluege et al., 2020: PFAS have been used as mould release agents, foam blowing agents, in the etching of plastic, as antiblocking agents for rubber, and as curatives for fluoroelastomer formulations.

Named polymers: thermoplastics, polypropylene, epoxy resins, and polyurethane elastomer foam mouldings.

Please feel free to add also more search terms if needed.

Commented [A5]: Question to DE: With the search term "plating" also other plating types (Nickel) will be targeted. Is this in the scope of this exercise or should we concentrate on Cr?

Gluege et al., 2020: at least also Ni and Cu

Please feel free to add also more search terms if needed.

Commented [A6]: Question to whom it may concern:

Does this application also include production and processing of other plastics than fluoropolymers?

Please feel free to add also more search terms if needed.

3. Documentation Sheet

As highlighted in the kick-off meeting the documentation sheet will contain:

- Bibliographic information on the reference
- Substances addressed (if available with CAS and structural formula (SMILES))
- Brief generic method description/classification
- Sample amount used
- Pre-treatment of sample
- Extraction method
- Clean up method
- Information on the measurement/detection/instruments used
- Quantification method
- Working range of the method
- Possible matrices
- Reported levels – in the case indicated
- Information on validation of the method
- Limitations (e.g. reported matrix effects)
- LOD and LOQ
- The quality level of reference and further comments

The information sheet will be built in Excel and Ramboll/VITO will make sure, that the contained information is easily accessible by for example sorting via text search. Furthermore, to make the data comparable reported levels will be given in one specific unit range (for example μ) and will be also additionally calculated in ppm.

In [Figure 1](#) an exemplary table showing the documentation sheet is shown. Please be aware that not all points addressed above are considered within this figure.

Reference	PFAS	Intake dw	Extraction	Clean up	Measurement	Matrix and reported levels (in μ g/kg dw)	LoD/LoQ
DIN 38414-14	C4-C10 PFCA C4-C8 PFSA	1 g	Sonication with MeOH	SPE WAX (optional) Elution with MeOH 0.1% NH ₃	HPLC-ESI(-)-MS/MS	Soil Sediment Sludge	LoD: 10 μ g/kg
ASTM D7568-17	C4-C14 PFCA C4-C8 PFSA PFECIS FHpPhA 6:2 FTCA 8:2 FTCA 10:2 FTCA 2H-perfluoro-2- decenoic acid 2H-perfluoro-2- octenoic acid	2 g	Vortexing and shaking with 50:50 MeOH/water and 50:50 MeOH/water/NH ₃ (pH 9-10)	-	UPLC-ESI(-)-MS/MS	Soil	LoD: 0.01-0.25 μ g/kg RL: 0.25 μ g/kg
Munoz 2016	C5-C18 PFCA C4-C10 PFSA FOA 6:2 FTUA 8:2 FTUA 5:3 FTCA 7:3 FTCA PFOA PFOS PFOA/NO PFOS/NO PFOA/MS PFOS/MS PFOA/MS	1 g	Vortexing and sonication with MeOH (20 mM NaOH) (2x)	ENVI-Carb Washing with MeOH	UPLC-HRMS (Q-Exactive, RS 70.000)	Sediment <LOD 4.2 μ g/kg dw	LoD: 0.0006-0.46 μ g/kg
Huset 2018	C4-C8 PFCA C4-C8 PFSA	5 g	Sonication with MeOH (1% NH ₃) (3x)	ENVI-Carb	HPLC-ESI(-)-MS/MS	Soil	LoQ: 0.01-0.03 μ g/kg
Joerss 2019	C4-C14 PFCA C4-C10 PFSA PFECIS HFPO-DiA HFPO-TriA HFPO-TetraA	5 g	Vortexing and sonication with water (1% HAc) and MeOH/water (1% HAc) (2x)	Oasis WAX Elution with 80/20 MeOH/water and MeOH (0.1% NH ₃)	HPLC-ESI(-)-MS/MS	Sediment <LoQ 2 μ g/kg	LoQ: 0.006-0.5 μ g/kg

Figure 1: Exemplary table showing the documentation sheet