KEMI
Swedish Chemicals Agency

PFAS in chemical products and articles

An enforcement project with focus on restrictions in the POPs Regulation on PFOA and PFOS

ENFORCEMENT 3/22

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KEMI
Swedish Chemicals Agency

The Swedish Chemicals Agency is supervisory authority under the Government. We work in Sweden, the EU and internationally to develop legislation and other incentives to promote good health and an improved environment. We monitor compliance of applicable rules on chemical products, pesticides and substances in articles and carry out inspections. We also provide inspection guidance for municipalities and county councils. We review and authorise pesticides before they can be used. Our environmental quality objective is A Non-toxic Environment.

Article number: 511 443

Preface

This report summarizes the Swedish Chemicals Agency's enforcement project on the occurrence of PFOA and PFOS in chemical products and articles.

The project is an initiative in the direction of the Swedish Parliament's environmental quality objective A Non-Toxic Environment, for which the Swedish Chemicals Agency is responsible. The project is also part of a collaboration within the Nordic working group for enforcement (NTG). NTG is a subgroup of the Nordic Working Group on Chemicals (NKE).

This is the first time that the Swedish Chemicals Agency enforces the restriction of PFOA, PFOA salts and PFOA-related compounds in chemical products and articles that came into force on 4 July 2020.

The project was carried out by the Swedish Chemicals Agency's enforcement department. Amanda Rosen and Maryam Ashja have been project managers. Also participating were Kristina Karlsson, Susan Strömbom and Björn Jonsson.

The Swedish Chemicals Agency

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Summary

PFAS (Per- and polyfluoroalkyl substances) is a large group of synthetically produced organic compounds with many uses in both industry and consumer products. They occur as for example surfactants in metal plating, in cosmetics and firefighting foams and in textiles and paper packaging to make them repellent to water, grease and dirt. They are considered particularly dangerous because they are extremely difficult to degrade in the environment and therefore stay in the environment for a long time. On 4 July 2020, a restriction was introduced in the POPs Regulation[1] that regulates the production, placing on the market and use of PFOA[2].

This report describes the Swedish Chemicals Agency's enforcement project on the presence of PFAS in chemical products and articles. The purpose of the project has been to

- make companies aware of the new restriction of PFOA, PFOA salts and PFOA-related compounds in the POPs Regulation,
- investigate the presence of restricted PFAS in chemical products and articles available on the market,
- ensure that companies take action if products and articles do not meet the requirements of the legislation and
- examine how the enforcement of the new restriction on PFOA can be carried out.

The project is part of a collaboration within the Nordic working group for enforcement (NTG). Within the framework of the project, we also contribute data to a survey of PFAS in articles and chemical products. The survey is part of the Swedish Chemicals Agency's investment in international chemical work and aims, among other things, to gather information for future development of legislation.

In total, we analysed 31 chemical products and 31 articles. Among the chemical products that were analysed, there were three ski waxes that contained restricted PFAS in concentrations above or around the limit values in the POPs Regulation, while none of the analysed articles contained restricted substances above limit values. Many products and articles contained PFOA and PFOS in levels below the limit values, and many contained PFAS substances that are not yet restricted in legislation.

We have also analysed extractable organic fluorine (EOF), which provided information on the presence of PFAS that was not included in the targeted analyses. The analyses showed high levels of organic fluorine in for example ski waxes, textiles, and firefighting foam. Some of it could originate from restricted PFAS.

Many of the unrestricted substances found in products and articles may be subject to restrictions in the future. Companies that place chemical products and articles on the market need to start working to phase out these substances from production.

The PFOA and PFOS restrictions include hundreds of substances. For many of them there is still a shortage of available information on occurrence and use, identification numbers (CAS or EC numbers) and external reference standards for quantitative analyses. There is a great need to develop methods for targeted analyses of PFAS to make possible a more effective enforcement and a phase-out of PFAS from production.

[1] Regulation (EU) No 2019/1021

[2] The POPs Regulation restricts PFOA, its salts and PFOA-related compounds. To avoid repetition, we have in this report chosen to write PFOA even when we refer to PFOA, its salts and PFOA-related compounds.

1 Introduction

1.1 Problem description

PFAS, short for *per- and polyfluoroalkyl substances*, is a collective name for a large group of synthetically produced organic compounds, all of which consist of a carbon chain where the hydrogen atoms have been completely or partially replaced by fluorine atoms. Due to their chemical construction, they have, for example, grease and water repellent properties and the ability to form thin layers on surfaces. PFAS is used in many different articles and products, such as grease and dirt repellent textiles, coatings in frying pans, impregnating agents for textiles, polish and wax for floors, and ski wax. The substances are also used as process chemicals in various industries.

All PFAS are extremely difficult to degrade, by themselves or as degradation products, and therefore remain in the environment. In addition, some PFAS substances, such as PFOA and PFOS, are toxic and bioaccumulative, meaning that they can accumulate in tissues. PFAS can also be spread far and wide and is therefore a global problem.

There are several studies that show that PFAS substances are used in consumer products, see section 2.

1.2 Existing legislation

Due to the environmental and health hazards associated with them, certain PFAS substances have been regulated in legislation. PFOS and its derivatives[3] have been banned in the REACH Regulation since 2008. The regulation originally existed in the so-called restriction directive. Since 2009, PFOS has been regulated within the Stockholm Convention[4] and the POPs Regulation[5].

PFOA, PFOA salts and PFOA-related compounds (substances that can be degraded to PFOA) have been banned globally with certain time-limited exemptions for use, for example in firefighting foam. This was decided in May 2019 by the parties in the Stockholm Convention. The restriction entered into force on 4 July 2020 through an amendment to the POPs Regulation and came into force immediately.

Article 3 of the Regulation states that substances listed in Annex I (including PFOA and PFOS) and II to the Regulation shall not be manufactured, placed on the market or used, either on their own, in mixtures or as constituents in articles.

Article 4 of the Regulation contains general exemptions to the provisions on prohibitions. The exemptions apply, among other things, to substances that occur as unintentional trace contaminants[6] in substances, mixtures or in articles. Substances present as constituents of

[3] Derivative – chemical compound that can be derived from or produced from another chemical compound.
[4] The Stockholm Convention contains a list of persistent organic pollutants (POPs) that are banned or restricted. The objective of the convention is a global phase out of substances that are persistent in the environment, are being absorbed by plants and animals, and have negative effects on human health or the environment.
[5] The EU POPs Regulation is implementing the Stockholm Convention by banning or restricting the use of the POPs substances in both chemical products and articles within the EU. The POPs Regulation is also implementing the POPs Protocol to the Convention on Long-range Transboundary Air Pollution (CLRTAP).
[6] Unintentional trace contaminant – a level of a substance that is incidentally present in a minimal amount, below which the substance cannot be meaningfully used, and above the detection limit of existing detection methods to enable control and enforcement.

articles already in use[7] before the entry into force of this Regulation are also excluded. Substance specific exemptions are listed for each of the substances in Annex I.

Unintentional trace contaminants can be permitted in chemical products and articles only if they are present in a content that does not exceed the specified limit values for PFOA and PFOS in Annex I to the POPs Regulation, see Table 1. This means that if PFOA and PFOS occur in higher concentrations, it is considered a violation of the restriction. In other words, it is forbidden to intentionally add these substances to chemical products and articles, regardless of content.

Table 1. Limit values for PFOA and PFOS occurring as unintentional trace contaminants

Restricted substances	Limit value for unintentional trace contaminants
Perfluorooctane sulfonic acid and its derivatives (PFOS)	up to 10 mg/kg (0.001 % by weight) where it is present in substances or in mixtures, up to 1 µg/m2 when present in textiles and other coated materials
Perfluorooctanoic acid (PFOA) and its salts	up to 0.025 mg/kg (0.0000025 % by weight) where they are present in substances, mixtures or articles
PFOA and its salts where they are present in polytetrafluoroethylene (PTFE) micropowders produced by ionising irradiation or by thermal degradation as well as in mixtures and articles for industrial and professional uses containing PTFE micropowders	up to 1 mg/kg (0.0001 % by weight)
Any individual PFOA-related compound or a combination of PFOA-related compounds	up to 1 mg/kg (0.0001 % by weight) where they are present in substances, mixtures or articles

1.3 Development of new legislation

Further restrictions on PFAS are underway. For example, perfluorohexanesulfonic acid (PFHxS), its salts and related compounds are expected to be included in the Stockholm Convention in 2022. This would in the long run mean a global phasing out of these substances. In addition to the restrictions that have been introduced or are planned to be introduced in the Stockholm Convention, there are already existing and planned restrictions in the REACH Regulation. A group restriction for perfluorinated carboxylic acids with 9–14 carbon atoms and substances that can be degraded into these will come into force in February 2023. Work is currently underway to develop restrictions on perfluorohexanesulfonic acid (PFHxS) and perfluorohexanoic acid (PFHxA).

There is a common view within the EU that PFAS should be treated as a group in the development of new legislation. Therefore, Sweden, together with several other member states, has begun work on developing a broad restriction proposal in Annex XVII of the REACH Regulation which covers all PFAS substances, except those that are already restricted.

[7] Use – Processing, formulation, consumption, storage, keeping, treatment, filling into containers, transfer from one container to another, mixing, production of an article or any other utilisation. (Definition according to the REACH Regulation)

2 Previous studies of PFAS in products

2.1 The Swedish Chemicals Agency's enforcement project "Highly fluorinated substances in clothing, footwear and chemical products" 2007–2008

In 2007 and 2008, the Swedish Chemicals Agency carried out a project focusing on "substances for water and dirt-repellent function". During the project, 27 suppliers of clothing and shoes were inspected, primarily for sports and outdoor products, as well as several manufacturers and suppliers of chemical products for impregnating textiles and leather available for consumers.

We investigated what knowledge the companies had about the legislation, and how they complied with it. The project did not include any analyses, but through our discussions with the companies, we tried to identify which products and substances were used in the clothing and footwear industry to achieve water-, oil-, and dirt-repellent function. We also wanted to convey information and knowledge to companies about highly fluorinated substances and the problems associated with them.

The restriction of PFOS had not yet come into force when we carried out the project. Our impression after the inspections was that PFOS had already been replaced by other substances, but that many companies were unaware of the problems with highly fluorinated substances. Few companies had sufficient knowledge about which substances were used instead of PFOS in the manufacture of their articles and products.

The survey was made even more difficult by the fact that many of the companies didn’t have direct access to information and often had to request it from their suppliers. Sometimes the suppliers regarded the information as trade secrets and therefore provided very non-specific data.

The survey showed that the use of fluorine-free alternatives was increasing, and a handful of companies had tried such or had plans to do so. These were usually products based on silicon compounds (silanes, siloxanes, silicones) or different types of waxes. (the Swedish Chemicals Agency 2009)

2.2 Municipal enforcement project on chemicals in work and promotional clothing in 2014

The municipal environmental administrations in Helsingborg, Malmö, Gothenburg and Stockholm cooperate on chemical enforcement with a focus on chemicals in articles. In 2014, a joint inspection project was carried out with a focus on chemicals in workwear and promotional clothing[8]. The environmental administrations visited stores and selected a total of 18 products for analysis of PFOS and PFOA. No elevated levels of these substances were found in the analyses. (Gothenburg Municipality 2014)

2.3 The Swedish Chemicals Agency's enforcement project on clothing and shoes 2016

In 2015 and 2016, the Swedish Chemicals Agency inspected 49 companies in the clothing and footwear sector. During the project, 192 product samples were checked, some of which were

[8] Promotional clothing – clothing provided with a logo or a company name

analysed for PFOS, PFOA and some other PFAS substances. We found low levels of PFOA, PFBA, PFHxA and PFNA in a children's winter overall and in shoes and rain jackets for children and adults. (The Swedish Chemicals Agency 2016)

2.4 The Swedish Chemicals Agency's analysis on total fluorine (TF) in chemical products and articles 2016

The Swedish Chemicals Agency carried out an analysis project in 2016 to investigate the content of so-called total fluorine (TF) in several chemical products and articles, for example: baking tins, car wax, furniture polish, shoe wax, floor polish and textiles. In addition, the occurrence of 22 specific PFAS was investigated. PFAS were detected in all products with a few exceptions. The products that contained the highest levels of TF were dental floss, baking tins and baking paper with non-stick function as well as tablecloths. (Borg & Ivarsson 2016) The project was a follow-up to the Nordic Risk Assessment Project (NORAP) which was implemented in 2015. (Blom & Hanssen 2015).

2.5 Municipal enforcement project on PFAS in ski waxes, cosmetic products and carpets 2018

The municipal environmental administrations in Helsingborg, Malmö, Gothenburg, and Stockholm collaborated in 2018 in a project where they visited stores and analysed articles and products to identify possible PFAS substances. The focus was on ski waxes, cosmetics, and carpets. The project analysed 37 products and articles, 29 of them contained PFAS, but usually in very low concentrations. However, the inspections showed that seven ski waxes and one foundation contained such high concentrations of PFOA that they would not be allowed to be manufactured or sold in the EU after the new restriction of PFOA came into force. (Gothenburg Municipality 2019)

3 The aim of the project

The restriction of PFOA in the POPs Regulation entered into force on 4 July 2020 and this is the first time it has been controlled in enforcement. In this project we wanted to

- make companies that place chemical products and articles on the Swedish market aware of the new restriction of PFOA in the POPs Regulation,
- investigate the presence of PFOA and PFOS in chemical products and articles available on the market, and ensure that companies take action in cases where products and articles do not meet the requirements of the legislation,
- examine how the enforcement of the new restriction can be carried out.

4 Our approach

The focus of the project was established within the Nordic working group for enforcement (NTG). Participating countries have been Denmark, Finland, Iceland, Norway, and Sweden. During the project, the countries met several times to exchange experiences and discuss the selection of product categories for analysis. At the same time, an internal collaboration was initiated at the Swedish Chemicals Agency, where we discussed the possibilities for a broad mapping of PFAS within the same project, with the aim of gathering information for future development of legislation.

The Swedish Chemicals Agency has also had a discussion with Stockholm University and Örebro University, among others, to ensure that the analytical methods used in the project are reliable.

All companies whose products we controlled have been contacted for information about the results of the analyses, and non-compliances have been followed up.

4.1 Delimitation

We have limited the project to the analysis of chemical content with respect to the restrictions of PFOS and PFOA in the POPs Regulation and have excluded enforcement in accordance with the REACH and CLP Regulations.

4.2 Selection of chemical products and articles

The restrictions of PFOS and PFOA apply to both products for professional use and consumer products. Within the framework of this project, we chose to focus on chemical products and articles that are available to consumers.

We have analysed the chemical content of primarily textile articles with dirt and water-repellent treatment, as well as chemical products that we suspected could contain PFAS. In the sampling, we used experience from previous inspection projects, research in the field and information on the content of PFAS in chemical products that companies had reported to the Swedish Chemicals Agency's product register. We also made selections directly when purchasing in stores, by reading information on labels and, if necessary, also on the brands' websites. We selected a total of 62 samples from 30 companies, see Table 2 for more information on product categories.

Table 2 Number of products and articles divided by product category

Product category	Quantity
Floor care products	5
Bicycle care products	7
Ski waxes	8
Fire extinguishers	5
Shoe care products	4
Textile impregnation products	2
Shoes	9
Gloves	3
Jackets	12
Tents and tent accessories	3
Backpacks	4
In total	**62**

4.3 Selection of substances for analysis

PFAS is a complex and large group of substances and the number of substances in commercial use is very high. The OECD has identified that there are more than 4,700 PFAS globally (OECD 2021). Hundreds of PFAS are estimated to be degradable to PFOA and PFOS. Many of them still lack available information on occurrence and use, identification numbers (so-called CAS or EC numbers) and access to certificated external reference materials for quantitative analyses.

Many commercial laboratories today have analytical packages with quantitative analyses of about 30 individual PFAS, so called targeted analyses. The most common packages include about twenty individual PFAA (perfluorinated alkyl acids) as well as several precursors to PFAA. However, the PFAS that are analysed commercially are only a fraction of those on the market and in the environment. (Swedish Chemicals Agency 2021a)

In this project, quantification of the individual PFAS has been carried out by the Norwegian Institute for Air Research (NILU), which has used its subcontractor Örebro University to perform analyses of extractable organic fluorine (EOF). NILU has been able to offer an analytical package consisting of totally 36 substances, see Table 3.

Extractable organic fluorine (EOF) was also analysed to obtain a measure of the total occurrence of PFAS in a sample. An EOF analysis does not provide any information on which individual PFAS are included but can in combination with quantitative analyses give an indication of whether there is a large proportion of unidentified PFAS in a sample. (Swedish Chemicals Agency 2021b)

Table 3 Substances analysed in the project

Abbreviation	The complete name of the substance
4:2 FTS	4:2 Fluorotelomer sulfonic acid
6:2 FTS	6:2 Fluorotelomer sulfonic acid
8:2 FTS	8:2 Fluorotelomer sulfonic acid
10:2 FTS	10:2 Fluorotelomer sulfonic acid
PFBS	Perfluorobutane sulfonate
PFPS	Perfluoropentane sulfonate
PFHxS	Perfluorohexane sulfonate
PFHpS	Perfluoroheptane sulfonate
PFOS	Perfluorooctane sulfonate
PFNS	Perfluorononane sulfonate
PFDS	Perfluorodecane sulfonate
PFHxA	Perfluorohexanoate
PFHpA	Perfluoroheptanoate
PFOA	Perfluorooctanoate
PFNA	Perfluorononanoate
PFDA	Perfluorodecanoate
PFUnDA	Perfluoroundecanoate
PFDoDA	Perfluorododecanoate
PFTrDA	Perfluorotridecanoate
PFTeDA	Perfluorotetradecanoate
PFHxDA	Perfluorohexadecanoate
PFODA	Perfluorooctadecanoate
FOSA	Perfluorooctane sulfonamide
N-MeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid
N-Et-FOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid
4x3 PFECA	Perfluoro(2,5,8,10-tetramethyl-3,6,9-trioxaundecanoic) acid
PFECHS	Perfluoro(perfluoroethyl)cyclohexanesulfonic acid
GenX	Perfluoro-2-methyl-3-oxahexanoic acid
4:2 FTOH	4:2 Fluorotelomer alcohol
6:2 FTOH	6:2 Fluorotelomer alcohol
8:2 FTOH	8:2 Fluorotelomer alcohol

Abbreviation	The complete name of the substance
10:2 FTOH	10:2 Fluorotelomer alcohol
N-MeFOSA	Methylperfluorooctane sulfonamide
N-EtFOSA	Ethylperfluorooctane sulfonamide
N-MeFOSE	Methylperfluorooctane sulfonamidoethanol
N-EtFOSE	Ethylperfluorooctane sulfonamidoethanol

4.4 Analytical method

Articles and chemical products were purchased from physical shops or web shops by the Swedish Chemicals Agency and sent to NILU in Norway for analysis in the autumn of 2020.

4.4.1 Comparison between standardized analytical method for PFOS and method used for PFOS analyses in this project

Paragraph 5 under the relevant post for PFOS in the POPs Regulation states that the standards adopted by the European Committee for Standardization (CEN) shall be used as test methods to demonstrate that substances, mixtures, and articles comply with the requirements of paragraphs 1 and 2 under the same post. As an alternative to the CEN standard, another analytical method may be used that gives corresponding results. In this project, the laboratory has used a method for analysis of PFOS that is equivalent to the standardized method DS/CEN/TS 15968:2010, “Determination of extractable perfluorooctanesulphonate (PFOS) in coated and impregnated solid articles, liquids, and firefighting foams – Method for sampling, extraction, and analysis by LC-qMS or LC-tandem/MS”.

4.4.2 Preparation of analytical samples

The samples, which consisted of 31 chemical products and 31 articles, were unpacked, and inspected by laboratory personnel. To assess the analytical variation and ensure the reliability of the results, two subsamples were taken from each product or article. Subsamples were taken from articles, if possible, from surfaces with the same colour and material and without seams and prints. Some articles such as shoes and gloves consisted of heterogeneous material or material in several layers. In these cases, the samples were taken from different parts of the articles. This was done to get a representative selection of the entire product.

The articles were hung on a hanger and covered with a polypropylene plastic bag to avoid contact with each other. This was a precautionary measure to avoid cross-contamination between samples in the laboratory. However, the textiles may have been contaminated by adjacent goods in the shops before they arrived at the laboratory.

Fire-fighting foam was drained from the original containers into cleaned glass bottles. The pressure vessels were deactivated before the contents were drained. This was done to ensure that the subsamples were not contaminated by the container pipes and valves. A partial sample (0.5 ml) was sent to Örebro University for determination of EOF.

4.4.3 Quantification of individual PFAS

For analysis of ionic and volatile PFAS, the samples were diluted 100 times with acetonitrile before adding 20 different 13 C-labelled internal standards to the sample extract. Subsequently, the samples were analysed by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) for ionic PFAS and gas chromatography coupled to mass spectrometry (GC/MS).

Quality assurance was performed by processing a blank sample with each sub-sample.

4.4.4 Analysis of EOF

Chemical products were diluted 1000 times with acetonitrile before the analysis. The sample extract was analysed on a CIC system with a combustion module (oven temperature 1000–1050 °C), an autosampler, an absorber module and an ion chromatograph (IC). The anions were separated with an ion exchange column with carbonate buffer as eluent and isocratic elution. The hydrogen fluoride (HF) formed during combustion was absorbed in MilliQ water (in the absorber module). The concentration of fluoride ions was measured with IC.

4.4.5 Quality assurance

All equipment used was disposable or thoroughly cleaned between samples. All solvents were tested for PFAS content before use. A negative control sample was included in each sample series for extraction. None of the tested PFAS were detected in the negative controls. Each sample was extracted and analysed twice. Detection limits were calculated based on a calibration curve for each individual PFAS.

For the analyses of EOF, the background levels of fluoride ions varied from day to day. The instrumental background level of fluoride was measured at 8 ng F (geometric mean based on 9 replicates). The analysis of EOF in samples was only started when the relative standard deviation (RSD) for three negative control samples was below 5 %. Another negative control sample was analysed after every fifth sample to monitor that no transmission occurred. The mean value of the negative control samples was subtracted from the test results before. To evaluate the stability of the system, a PFOA standard of 240 ng F/ml was injected between every tenth sample. The mean value of the standard injection was 251 ng F ml (RSD: 13 %, n = 10). The variation within a day was at most 14 % and between days at most 15 %). The method has been evaluated in "Interlaboratory Comparison of Extractable Organofluorine (EOF) - Analysis of water, effluent and sludge" (Swedish Chemicals Agency 2021).

To evaluate the accuracy and precision of the method, 25 ng native PFAS standards containing 23 of totally 36 PFAS included in the method were added to three textile samples which were then analysed. Analysis of these showed good recovery for all PFAS and low analytical variation between the samples.

5 What did we find?

We analysed totally 31 chemical products and 31 articles purchased from 30 different companies. All articles and products are listed in Appendix 1. The results of the analyses are presented below, first for the chemical products and then for the articles. Finally, a summary of the results for different product groups is presented.

Two of the analysed ski waxes contained restricted PFAS in concentrations above the limit values in the legislation, Red Creek High Fluor Super Glider and Rode GLF50 Glider. Two ski waxes contained restricted PFAS substances below the limit values. One of these was just below the limit value and could possibly constitute a violation of the restriction. We have communicated about this with the company. Among the chemical products examined, 16 contained only unrestricted PFAS, that is, substances that are not yet restricted in the legislation. Eleven products did not contain any of the substances analysed. See Figure 1 below.

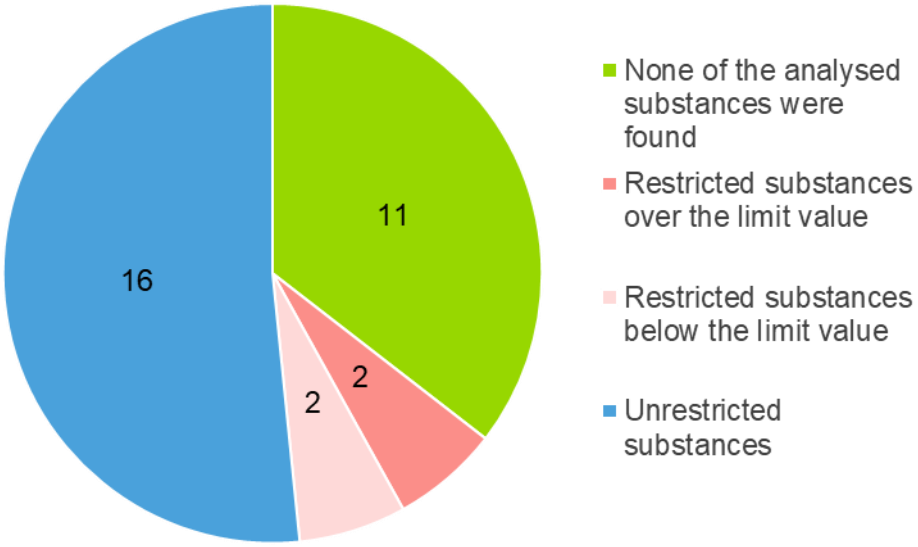

Figure 1 Results from the analysis of chemical products, divided into four categories

None of the analysed articles contained restricted substances in concentrations above the limit values in the legislation. In five of the articles, we found PFAS substances that are not restricted in the legislation. In 22 of the articles, we found restrictedPFAS substances in concentrations below the limit value, of which all but two articles also contained substances that are not restricted yet. Among the articles we analysed, four did not contain any of the substances analysed, see Figure 2. None of the substances found in the articles are on the candidate list.

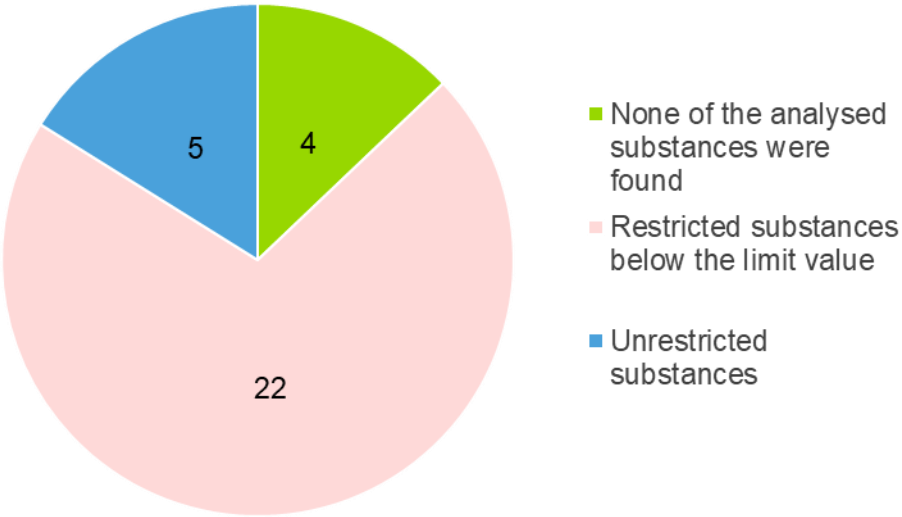

Figure 2 Results from the analysis of articles, divided into three categories

Table 4 and Figure 3 show the results of the analyses divided into the different product categories. The ski wax category was the only one where we found limited substances above the limit value.

Table 4 Results from analyses of articles and products for each product category

Product category	Total number of products/ articles	Number of products/ articles where none of the analysed substances were found	Number of products/ articles with restricted substances over the limit value	Number of products/ articles with restricted substances below the limit value	Number of products/ articles with only unrestricted substances
Floor care products	5	2	-	-	3
Bicycle care products	7	5	-	-	2
Ski wax	8	2	2	2	2
Portable fire extinguishers	5	-	-	-	5
Shoe care products	4	2	-	-	2
Textile impregnation products	2	-	-	-	2
Shoes	9	3		4	2
Gloves	3	1	-	2	-
Jackets	12	-	-	11	1
Tents and tent accessories	3	-	-	2	1
Backpacks	4	-	-	3	1
In total	**62**	**12**	**2**	**24**	**21**

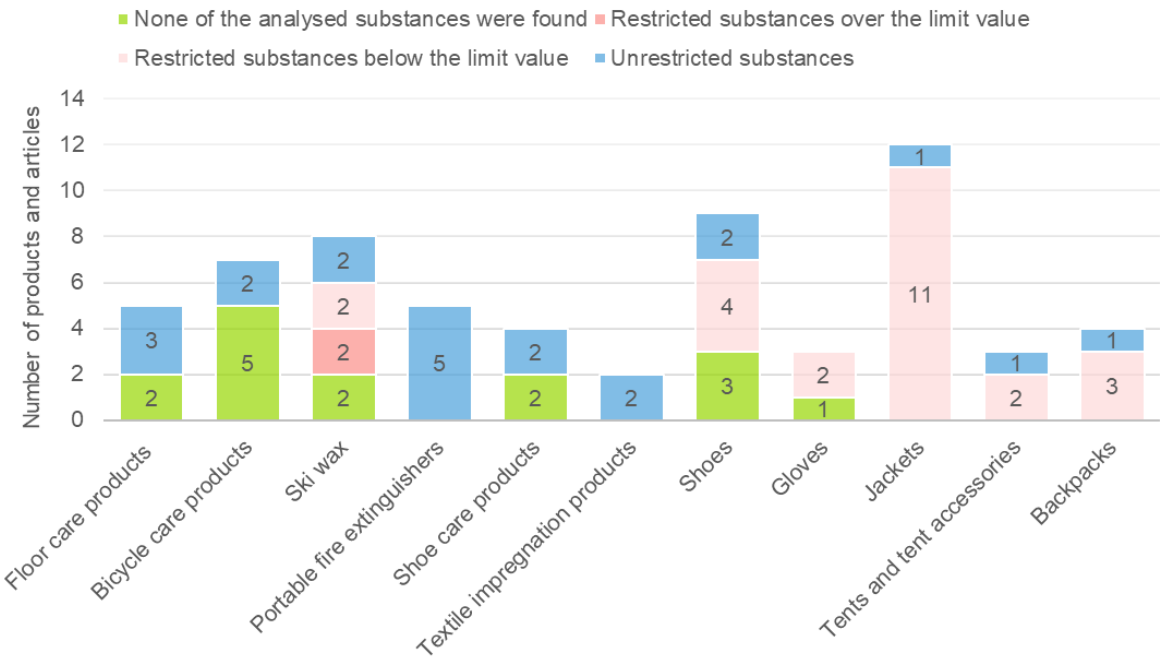

Figure 1 Results from analyses of articles and products for each product category

5.1 PFAS in portable fire extinguishers

The analyses showed that the substance 6:2 FTS was present in firefighting foam at a concentration of 0.28–10.6 mg/kg. This is comparable to the concentrations of the same substance that were detected in a previous study carried out by the Swedish Chemicals Agency in collaboration with Örebro University (Swedish Chemicals Agency 2015). The content of 6:2 FTS in the samples is relatively low and can probably be linked to contaminants from the manufacturing process. It can also be caused by other PFAS substances being degraded to 6:2 FTS during storage.

5.2 EOF analysis

In this project, the Swedish Chemicals Agency has also commissioned analyses of extractable organic fluorine (EOF). The EOF content provides valuable information on the presence of PFAS that could not be identified in the targeted analyses in this project. The analyses showed high EOF levels in, for example, ski waxes, textiles and firefighting foam. However, it is difficult to draw conclusions from the EOF analyses on the type of PFAS substances present in the sample.

It should also be mentioned that the extraction methods differ between articles and chemical products and between different types of chemical products, which means that the results are not necessarily quantitatively comparable to each other. Also, as the chemical products were not extracted but only diluted with organic solvents and no separation of inorganic fluoride were done before analysis, this analysis should be regarded as total fluorine (TF) analysis for the chemical products. Despite these methodological shortcomings, the EOF analyses give a clear indication that the detection frequency and levels of PFAS in the examined articles and products are higher than what appears from the targeted analyses.

6 What measures have we taken in this enforcement project?

- We have contacted the companies who place the ski waxes that do not comply with the PFOA-restriction on the market in Sweden. We have done this in a so-called inspection notice where we have given the companies the opportunity to comment on the results of the analyses. For two of these ski waxes, the companies have announced that the product no longer is available. We will submit a report of suspicion of criminal offence to environmental prosecutors where applicable.
- Regarding the products and articles where we have not found any restricted PFAS in concentrations above the limit values in the legislation, we have sent information to the companies about the analysis results as well as about the POPs Regulation and other relevant legislation.
- Many products and articles contain restricted substances, but below the limit values in the legislation. As the restrictions in the POPs Regulation are formulated, the limit values can only be applied if the substances occur as unintentional trace contaminants. In other words, it is forbidden to intentionally add the restricted substances in chemical products and articles, regardless of content. As the levels detected have been far below the limit values and there is great uncertainty about the source of these substances, the Swedish Chemicals Agency has chosen to assume that the substances are not intentionally added.
- In cases where the companies have not submitted a business notification to the Product Register in accordance with current regulations[9], we have pointed this out in our communication with them.

7 Our conclusions

7.1 Ski waxes contained restricted substances above limit values

Three of totally eight analysed ski waxes contained PFOA at a level above or just below the limit values in the POPs Regulation. No other products and articles contained PFOA or PFOS above the limit values.

7.2 Many of the products contained restricted substances in relatively low levels

Many articles and products contained PFOA and PFOS in a concentration that was below the limit values in the POPs Regulation. It is forbidden to intentionally add PFOA and PFOS in products and articles to achieve a certain function, such as water and grease repellent properties. The limit values in the POPs Regulation only apply to unintentional trace contaminants that have arisen, for example, in the manufacturing process.

[9] Swedish Environmental Code (1998:808), Chemical Products and Biotechnical Organisms Ordinance (2008:245) and Swedish Chemical Agency's Chemical Products and Biotechnical Organisms Regulations

7.3 Are the substances unintentional trace contaminants or intentionally added?

It is extremely difficult to assess whether the PFOA and PFOS substances detected in the analytical samples are unintentional trace contaminants or whether they are intentionally added. In most cases, the concentrations are far below the limit value, which makes them less likely to fulfil a function in the article or product. However, it cannot be ruled out that a combination of PFAS with different chain lengths, for example C6 (PFHxA-related substances) and C8 (PFOA-related substances), in low concentrations may have been used to provide, for example, a dirt and water repellent function in an article or a product.

7.4 Unrestricted substances found in products and articles may be restricted in the future

Many products and articles contained unrestricted PFAS. The analyses performed in this project identified unrestricted substances such as PFHxA in all product and article categories examined, except in gloves. The analysis results for firefighting foam from portable fire extinguishers have shown the presence of PFHxA, 4:2 FTS and 6:2 FTS.

A proposal for an EU restriction on PFHxA is currently being assessed, which also includes PFHxA-related substances such as 6:2 FTS. In addition, work is underway to develop a broad restriction of PFAS, which will include 4:2 FTS.

7.5 Methods for targeted analyses of PFAS need to be developed

The PFOA and PFOS restrictions include hundreds of substances and many of them are still unknown. There are no identification numbers for many PFAS, such as CAS or EC numbers. There is also a lack of access to external standards for quantitative analyses. The laboratories that currently perform PFAS analyses offer an analysis package including 30–40 substances, a few of which are covered by the restrictions in the POPs Regulation.

Within the framework of this project, we have had 36 individual PFAS substances analysed, of which 13 are restricted in the POPs Regulation. We have also performed analyses of extractable organic fluorine (EOF), a measure of the total content of organic fluorine that can be extracted from an analytical sample. Relatively high levels of fluoride (mg F/kg sample) have been measured in many products and articles using the EOF method. This indicates that there is a large amount of undetected PFAS because the targeted analyses have only been able to identify a few substances. We note that there is a clear need to develop targeted analysis methods for individual PFAS. We believe that this is a prerequisite for the enforcement agencies to be able to conduct effective control and for companies to be able to work preventively with phasing out PFAS.

8 Discussion

Since we have only analysed a few products from each product group, it is difficult to draw conclusions about the situation on the Swedish market when it comes to the content of PFAS in different types of products. However, we can state that within all product groups there were products that contained unrestricted PFAS or restricted PFAS below the limit values in the POPs Regulation. This can be interpreted as the presence of these substances in the production, either intentionally added or as contaminants in, for example, water used in the

production process. Work will be required on the part of companies to live up to the requirements that the legislation will set in the future.

This is the first time we are enforcing the restriction of PFOA in the POPs Regulation. We have examined a very small proportion of the products on the market and the inspection was carried out only a couple of months after the restriction came into force. We soon need to return to this restriction in our enforcement to get a better picture of the compliance and to follow the development of analysis methods.

This project illustrates the difficulty of enforcing restrictions where the substances are largely unknown and where analytical methods still needs to be developed, partially due to lack of certified reference material on the market. It is important that the companies' possibilities to comply with the restrictions and the authorities' possibilities to enforce are considered when new legislation is developed.

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10 Glossary

Article: An object which during production is given a special shape, surface or design which determines its function to a greater degree than does its chemical composition (The REACH regulation)

Candidate list: List containing SVHC-substances in accordance with Article 59 in the REACH Regulation. The substances are candidates to be included in Annex XIV of REACH, which means that authorisation will be required to use them.

CAS number: Chemical substance identification number, assigned and registered by the Chemical Abstract Services (CAS), Columbus, Ohio.

Derivatives: Chemical compound that can be derived from or prepared from another given chemical compound.

EC number: Seven-digit identification number for chemical substances on the EU market. Substances that were on the market before 18 September 1981 are considered existing substances and start with numbers 200 or 300.

EOF: Extractable organic fluorine

Precursor: A chemical substance that through a chemical process is converted (partially degraded) to another substance, and after the last conversion step reaches a persistent stage

PFAA: Perfluorinated alkyl acid

PFAS: Per- and polyfluoroalkyl substances

PFOA: Perfluorooctanoic acid

PFOS: Perfluorooctane sulfonate

POPS-Regulation: Regulation (EU) No 2019/1021 of the European Parliament and of the Council on persistent organic pollutants

REACH-Regulation: Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals

Substances of Very High Concern: Substances that meet the criteria in Article 57 in the REACH Regulation. These are carcinogenic, mutagenic, toxic to reproduction, dangerous for the environment (persistent, bioaccumulative, toxic or very persistent and very bioaccumulative) or which have other serious properties, for example endocrine disrupting properties.

The Chemical Restrictions Directive: Council directive (76/769/EEC) of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations.

Annex 1 – Chemical products and articles analysed in this project

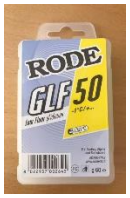
Table 1 Chemical products

Floor care products		
Product name/Description	**Brand**	**Picture**
Bona White (floor varnish)	Bona	
Bona Mega Extramatt (floor varnish)	Bona	
Parad (floor polish)	Nordex	
Tjockfilmslack EP (floor varnish)	Hagmans	
Lino Porfyllare (concrete impregnation)	Gipeco	

Bicycle care products		
Product name/Description	**Brand**	**Picture**
BIKE Kettenöl Wet (chain lubricant)	WD-40	
BIKE Kettenöl Dry (chain lubricant)	WD-40	
Trockenschmiermittel mit Teflon (chain lubricant)	Finish Line	
Bike Chain Spray (chain spray)	Sonax	
Lubricant Spray with Teflon (lubricant spray)	TF2 Ultimate	
BikeDryLube Teflon Spray (lubricant spray)	Ballistol	

Kettenspray für trockenheit (chain spray)	Muc-Off	

Ski waxes		
Product name/Description	**Brand**	**Picture**
High Fluor Super Glider +1/-12°C (glide wax for cross country skiing)	Red Creek	
HF Glider Orange +1/-5°C (glide wax for cross country skiing)	SkiGo	
Ultra Gel Glider +5/-10°C (glide wax for cross country skiing)	Start	
F4 Liquid Premium Cold -4°C and colder (glide wax for cross country and downhill skiing)	Swix	
RCF High Fluor Liquid Glider -2/-15°C (glide wax for cross country skiing)	Rex	
UF Cold Ultra Fluorocarbon Liquid Glide -3/-15°C (glide wax for cross country skiing)	Vauhti	

LF Hot Wax (glide wax for cross country skiing)	ToKo	
GLF50 Glider -1/+…°C (glide wax for cross country skiing)	Rode	
Portable fire extinguishers		
Product name/Description	**Brand**	**Picture**
Fire Extinguisher FE6TGA 6 L (foam fire extinguisher for class A & B fires)	Housegard	
Skumsläckare 6L (foam fire extinguisher for class A & B fires)	Nexa	
Skumsläckare 6L (foam fire extinguisher for class A & B fires)	Total	

Handbrandsläckare 6L (foam fire extinguisher for class A & B fires)	CGS	
Brandsläckare 6L (foam fire extinguisher for class A & B fires)	OSEC	

Shoe care products		
Product name/Description	**Brand**	**Picture**
Waterstop Colours (shoe polish)	Collonil	
Repel Waterproofing spray (waterproofing spray)	Ecco	
Rain & Stain Proofer Eco (waterproofing spray)	52bones	
Dirt Blocker (waterproofing spray)	Empire	

Textile impregnation products		
Product name/Description	**Brand**	**Picture**
Textilskydd (textile impregnation)	Texelent	
Textile Guard Pro Wash-In (textile impregnation)	Fibertec	

Table 2 Articles

Shoes		
Product name/Description	**Brand**	**Picture**
Vinterkängor (boots)	BLWR (Jula)	
Nero Dakar Trekking (boots)	Graninge	
Vandrarkängor (boots)	Cortina (Deichmann)	
Känga Sprigs (boots)	CRW (Höök s)	
MCK Discover II Mid AQX (boots)	McKinley (Intersport)	
Santiago GTX (boots)	Garmont	
Litewave Fastpack (shoes)	The North Face	
Authentic LTR GTX (boots)	Salomon	

Multi-Vent (shoes)	Ecco	

Gloves		
Product name/Description	**Brand**	**Picture**
Ergo Grip Active (outdoor gloves)	Hestra	
Apex Etip Glove (outdoor gloves)	The North Face	
Handskar Saide (riding gloves)	CRW (Hööks)	

Jackets		
Product name/Description	**Brand**	**Picture**
Rainy Day Shell Jacket (rain jacket)	Salomon	
Versa Barrier Jacket (bike jacket)	Pearl Izumi	

Allround Jacket (rain jacket)	Everest (Stadium)	
Apex Flex Dryvent Jacket (outdoor jacket)	The North Face	
Finnskogen Gore-Tex Jacket (hunting jacket)	Norrøna	
Cloud Ridge Jacket (outdoor jacket)	Patagonia	
Oppdal Insulated Jacket (outdoor jacket)	Bergans	
Saltro Jacket (outdoor jacket)	Helly Hansen	
Skaljacka (outdoor jacket)	BLWR (Jula)	
L.I.M Critus Jacket (rain jacket)	Haglöfs	

GoodTeal GTX Jacket (hunting jacket)	Beretta	
Softshelljacka Bolt Kent (outdoor jacket)	Bolt (Bauhaus)	

Tents and tent accessories		
Product name/Description	**Brand**	**Picture**
Nylon Tarp Poncho (tarp/rain poncho)	Sea to Summit	
Eco Trail 2 (2-person tent)	The North Face	
Hubba NX Fast & Light Body (tent floor)	MSR	

Backpacks		
Product name/Description	**Brand**	**Picture**
Hustle 5.0 Backpack (everyday backpack)	Under Armour	
Kitsilano Backpack (everyday backpack)	Helly Hansen	

Tempest 16 Backpack (hiking backpack)	Osprey	
Stormfront Roll Top Pack (outdoor backpack)	Patagonia	

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