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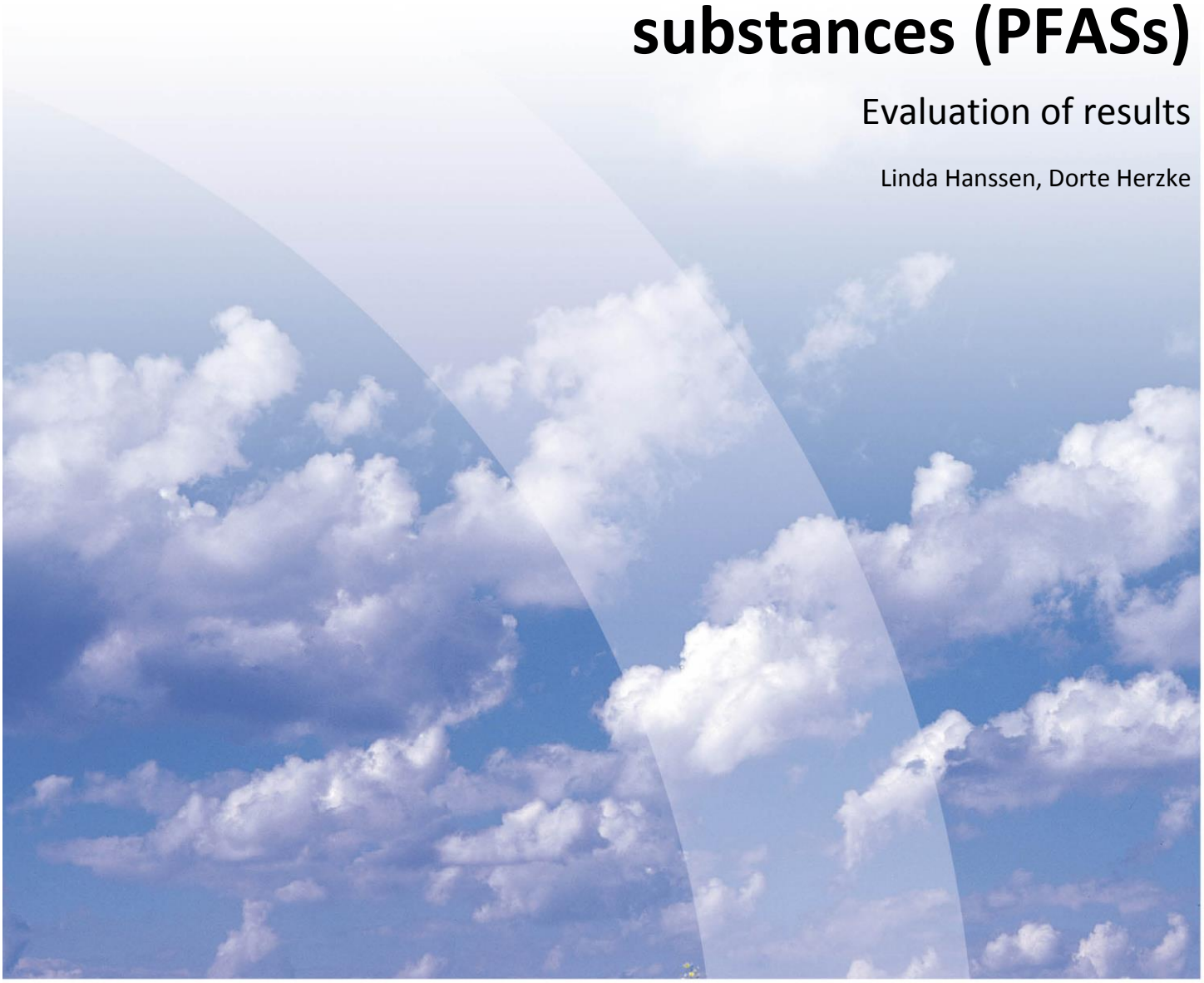
Investigation of outdoor textiles with respect to determine the content of ionic perfluorinated substances (PFASs)

Evaluation of results

Linda Hanssen, Dorte Herzke



Scientific report

Preface

Extract from § 2-32. Consumer products containing perfluorooctanoic acid (PFOA), (Product regulation FOR 2004-06-01 Nr. 922, **§** 2-32)

From June 1 there is a prohibition against production, import, export and distribution of consumer products which contains PFOA, as a pure substance or as a mixture when the mixture contains 0.001 weight percentage or more of the substance.

From June 1 there is a prohibition against production, import, export and distribution of textiles, carpets and other surface coated consumer products which contain PFOA, when the concentration in some parts of the product is higher than or equal 1 µg/m^2. Parts of the product means the materials of which the product is produced, and the product's individual components.

This prohibition does not apply to food containers, food contact material and medical equipment. It does not apply to spare parts of consumer products made available for trade prior to June 1 2014.

NILU has on behalf of the Norwegian Environment Agency determined the concentration of ionic PFASs, including PFOA, in outdoor clothing.

Contents

Summary

NILU has, on behalf of the Norwegian Environment Agency, determined the concentration of ionic perfluorinated substances (PFASs), including PFOA, in outdoor clothing. Of the investigated 12 items, PFAS was only detected in 2 of the items. Four samples contained PFOA exceeding the limit of 1 µg/m^2. The quality assurance where three replicates of one sample were extracted, had a relative standard deviation (RSD) less than 10% for all detected substances except one (PFTrDA). Other quality measures such as recovery calculations and blanks, show that the method used for extraction is suitable for these types of matrixes and substances. PFOS was not present in any of the items investigated, indicating that the textile industry manages to effectively avoid PFOS in their production processes.

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Evaluation of results

1 Samples

Samples were purchased by the Norwegian Environment Agency and shipped to NILU for analysis.

Table 1: Overview of the analysed outdoor clothing. Pictures are presented in the appendix.

NILU ID	Product	Brand	Model	Water resistance	Shop	Produced in
1	Jakke, dame	Arc'teryx	Acto MX Hoody W's Camellia, model 9559	DWR treated for outer layer performance	Sportsnett.no	China
2	Jakke, barn	Reflex	Bug jacket, 86 cm-18 mnd, pink, item no. 233434	Garment is waterproof, 5000 mm	*	China
3	Jakke	Skogstad	Apple 3-layer technical jacket, art. No. 214013	Waterproof, 10000 mm	G-sport	*
4	Bukse, dame	Fjällräven	Keb trousers W., art. 89235	Water resistant	G-sport	China
5	Jakke, unisex	Helly Hansen	Seaside jacket	Waterproof	XXL	China
6	Bukse, herre	Lundhags	AVHU Pant, item no. 1114018	Water repellent	XXL	Vietnam
7	Jakke, ungdom	Bergans	Evju youth jacket, art no. 6930	Waterproof, 10000 mm	XXL	Myanmar
8	Jakke, vattert, barn	Jotunheim	Bukkehøe mini, art. No. 271213-W13	Water repellent	Anton sport	Japan
9	Bukse	Norrøna	Falketind flex1 pants, Prod. No. 107937	Can resist some water	Anton sport	Vietnam
10	Jakke, dame	McKinley	Cedarville, WMS, art. No. 226855 001400	Water proof – even under extreme conditions	Intersport	China
11	Jakke, dame	Berghaus	Vapour storm shell JKT AF, LTPNK/LTGRN 420856M88	Gore-Tex, waterproof	Intersport	China
12	Jakke, dame	Didriksons	SAPI WNS JKT, art. no. 575367	100% waterproof, min 10000 mm	*	China

*Information not provided

2 Methods

To reduce the analytical uncertainty caused by inhomogeneity of the fabric, three pieces (10 x 10 cm) from different parts of the clothing, were cut out and homogenised. A subsample representing 100 cm^2, were used for analyses. To give insight into the variations of the chemical analyses as well as the inhomogeneous distribution of PFASs, all three sub samples were analysed for one textile item. More details about this is presented in the quality assurance section.
The samples were transferred to a 50 mL polypropylene tube, followed by addition of internal standard (25 ng) and 20 mL of methanol (Lichrosolv quality). The following PFASs were analysed using the internal standard method: PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTeDA, PFBS, PFHxS, PFHpS, PFOS, PFDS, 6:2 FTS, 8:2 FTS and FOSA (the abbreviations are listed in Table 5 in the appendix). After vortexing thoroughly, the samples were put in an ultrasonic bath for 30 minutes. Afterwards, the methanol extract was transferred to a new polypropylene tube and reduced to 2 mL. An aliquot was cleaned up with acidified Envicarb prior to the addition of recovery standard (brPFDA) and analysed on a UPLC-MSMS system. More details about the instrumental analysis can be found in Hanssen *et al.* (2013).

3 Results

The PFAS concentrations are presented in Table 2. Of the investigated 12 items, PFAS was not detected in 2 of them (sample 8 and 12). The perfluorinated carboxylates (PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA and PFTeDA) were detected in 10 of the 12 samples. Of these ten, four contained PFOA exceeding the limit of 1 $\mu g/m^2$. The PFOA content in the different samples is presented in Figure 1. For one sample, the sulfonate (PFBS) and fluortelomer sulfonate (8:2 FTS) were above the detection limit.

Table 2: The concentration of ionic PFAS (µg/m^2). Numbers in bold are concentrations above the limit of 1 µg/m^2 for PFOA. Concentrations below LOD are designated with "<" and the respective LOD concentration.

	1	2	3	4	5	6	7	8	9	10	11	12
4:2 FTS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
6:2 FTS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
8:2 FTS	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.51	<0.15
PFBS	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	<0.03
PFHxS	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFHpS	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFOS	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFDcS	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
FOSA	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
PFHxA	2.09	<0.60	1.33	7.97	<0.60	<0.60	<0.60	<0.60	<0.60	<0.60	2.87	<0.60
PFHpA	0.35	0.15	0.14	0.26	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	1.15	<0.06
PFOA	**4.80**	**1.08**	0.57	**2.83**	**1.39**	0.34	0.14	<0.06	0.73	0.22	0.63	0.08
PFNA	0.30	1.22	1.32	0.86	0.22	<0.15	<0.15	<0.15	<0.15	0.52	<0.15	<0.15
PFDA	1.19	0.84	<0.15	2.39	0.34	<0.15	<0.15	<0.15	<0.15	<0.15	0.24	<0.15
PFUnDA	<0.15	0.60	0.36	0.53	<0.15	<0.15	<0.15	<0.15	<0.15	0.23	0.06	<0.15
PFDoDA	0.57	0.63	<0.09	2.25	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	0.13	<0.09
PFTrDA	<0.05	0.29	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PFTeDA	<0.09	0.24	<0.09	0.56	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09

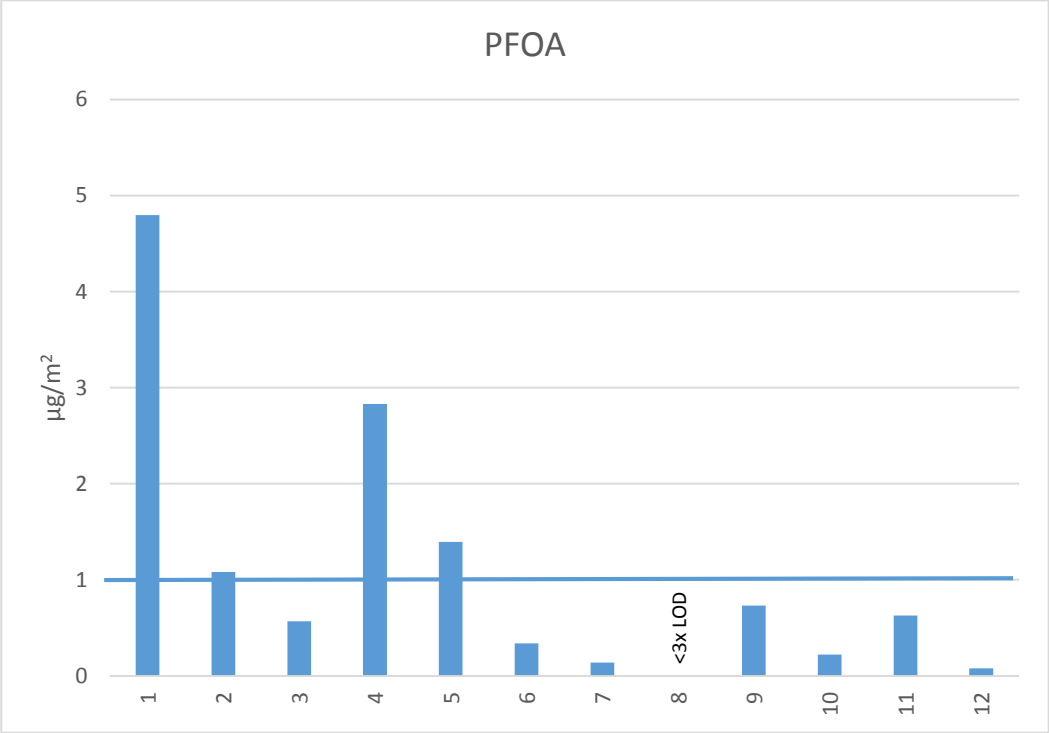


Figure 1: PFOA concentrations (µg/m^2) in the different items. The bold line indicate the 1 µg/m^2 concentration.

4 Quality Assurance

The extraction method applied only allows for the determination of the extractable PFAS. All PFAS chemically bound to a fluoropolymer are not accessible for the applied method. Using ^{13}C labelled internal standards for as many PFAS congeners as possible allows for a control of potential suppression of the analytical signal caused by matrix. Therefore, NILU uses a total of 14 ^{13}C labelled internal standards, which were added to the sample. To further assure the quality of the method, a certified reference material or a laboratory comparison test is part of PFAS analyses in general. However, for textiles no such material is available. To compensate for that, the recovery of the 14 ^{13}C labelled internal standards was used as an additional quality measure. The recovery differed between sample material and varied from 24 to 130%, with an average of 41%. Finally, blank controls give insight into possible contamination in the laboratory. Four blank samples were run together with the samples. None of the investigated PFASs were detected in blank samples.

The limit of detection (LOD) was determined by using three times the noise of the mass transition of each PFAS in every sample. The LODs are presented together with the results in Table 2, and ranged between 0.03 and 0.60 µg/m^2. The achieved LOD for PFOA of 0.06 µg/m^2 is well below the threshold of 1 µg/m^2 ensuring good quality of the data.

To further investigate the variation in concentration between three samples of the same textile, we chose sample 2 since the fabric was uniform in texture and colour and detectable PFAS concentrations of a broad variety were found, as well as slightly exceeding the PFOA threshold. The results are presented in Table 3.

Table 3: Three analysed replicates of sample 2. Concentrations in µg/m^2.

	Parallel 1	Parallel 2	Parallel 3	Average	Stdev	% RSD
4:2 FTS	<0.10	<0.10	<0.10	-	-	-
6:2 FTS	<0.10	<0.10	<0.10	-	-	-
8:2 FTS	<0.15	<0.15	<0.15	-	-	-
PFBS	<0.03	<0.03	<0.03	-	-	-
PFHxS	<0.15	<0.15	<0.15	-	-	-
PFHpS	<0.15	<0.15	<0.15	-	-	-
PFOS	<0.15	<0.15	<0.15	-	-	-
PFDcS	<0.30	<0.30	<0.30	-	-	-
FOSA	<0.15	<0.15	<0.15	-	-	-
PFHxA	<0.90	<0.90	<0.90	-	-	-
PFHpA	0.15	0.15	0.15	0.15	0.003	1.8
PFOA	1.08	1.07	1.10	1.09	0.02	1.1
PFNA	1.22	1.38	1.38	1.33	0.09	7.0
PFDA	0.84	0.83	0.82	0.83	0.01	1.1
PFUnDA	0.60	0.54	0.57	0.57	0.03	4.9
PFDoDA	0.63	0.63	0.64	0.64	0.01	0.9
PFTrDA	0.29	0.55	0.57	0.47	0.16	33
PFTeDA	0.24	0.28	0.27	0.26	0.02	8.5

RSD: relative standard deviation

5 Discussion

On general terms, an analytical method with uncertainties below 20% is acceptable. As shown in Table 3, the method applied by NILU results in relative standard deviations ranging between 0.9 and 8.5% which is well below the accepted uncertainty, with the exception of PFTrDA where the RSD was 33%.The increased uncertainty for PFTrDA could be explained by concentrations close to LOD and no ^{13}C labelled internal standard available for this compound. Applying a general uncertainty of 20%, the PFOA results for sample 2 could be considered to be below the limit of 1 µg/m^2 even though the parallel extractions shows that the average, as well as all the three replicates were above this limit.

The difference in PFAS content on fabrics within one sample could have an impact on the results. For sample 6, the density for the dark blue fabric was higher than the light blue fabric used on the same garment (see Table 4 in the appendix for pictures). However no PFOA from that particular item was detected, so we did not look further into this. Clothing consisting of a number of different fabrics are quite common in outdoor gear and a more detailed description of the samples are listed in Table 4. For analysis, pieces of each fabric were cut out and mixed together before extraction.

6 Conclusion

The PFOA concentration for the majority of the samples (8 of 12) was below the threshold of 1 µg/m^2. The quality assurance where three replicates of one sample was extracted, had a relative standard deviation less than 10% for all detected substances except one (PFTrDA). Other quality measures, such as recovery calculations and blanks, show that the method used for extraction are suitable for these types of matrices and substances. The higher content of PFHxA and PFOA in some samples are of interest with respect to volatile PFAS as a possible source, and would be of interest to study in future projects. PFOS was not found in the items investigated, indicating that the textile industry manages to effectively avoid PFOS in their production processes.

7 References

Produktforskriften *[Product regulation]* (2004) Forskrift om begrensning i bruk av helse- og miljøfarlige kjemikalier og andre produkter (produktforskriften). Fastsatt av Miljøverndepartementet (nå Klima- og miljødepartementet) 1. juni 2004. FOR 2004-06-01 Nr. 922, § 2-32. URL: https://lovdata.no/dokument/SF/forskrift/2004-06-01-922/KAPITTEL_2?q=PFOA#KAPITTEL_2

Hanssen, L., Dudarev, A.A., Huber, S., Odland, J.Ø., Nieboer, E., Sandanger, T.M. (2013) Partition of perfluoroalkyl substances (PFASs) in whole blood and plasma, assessed in maternal and umbilical cord samples from inhabitants of arctic Russia and Uzbekistan. *Sci. Total Environ., 447,* 430-437.

Appendix A

Samples analysed, PFAS abbreviations and analytical reports

Table 4: Pictures of the analysed samples and comments with respect to type of sample analysed.

Sample ID		Comment
1		Uniform in colour and texture.
2		Uniform in colour and texture.
3		The jacket consists of two different coloured fabrics. The sample pool was based on one dark blue and two light blue parts.
4		The trouser consists of two different coloured fabrics. The sample pool was based on one brown and two yellow parts.

5		The jacket consists of two different coloured fabrics. The sample pool was based on one black and two white parts.
6		The trouser consists of two different coloured fabrics. The sample pool was based on one dark blue and two blue parts.
7		The jacket consists of two different coloured fabrics. The sample pool was based on one dark blue and two blue parts.
8		Only the outer layer was analysed. The filling was removed prior to analysis.
9		Uniform in colour and texture.
10		Uniform in colour and texture.

11		The jacket consists of three different coloured fabrics. The sample pool was based on one green, one pink and one dark pink part.
12		Uniform in colour and texture.

Table 5: PFAS abbreviations.

Abbrevation	Full name
PFBA*	Perfluorobutanoic acid
PFPeA*	Perfluoropentanoic acid
PFHxA*	Perfluorohexanoic acid
PFHpA*	Perfluoroheptanoic acid
PFOA*	Perfluorooctanoic acid
PFNA*	Perfluorononanoic acid
PFDA*	Perfluorodecanoic acid
PFUnDA*	Perfluoroundecanoic acid
PFDoDA*	Perfluorododecanoic acid
PFTrDA	Perfluorotridecanoic acid
PFTeDA*	Perfluorotetradecanoic acid
PFBS	Perfluoro butane sulfonic acid
PFHxS*	Perfluorohexane sulfonic acid
PFHpS	Perfluoroheptane sulfonic acid
PFOS*	Perfluorooctane sulfonic acid
PFDcS	Perfluorododecanoic sulfonic acid
4:2 FTS	4:2 fluorotelomersulfonate
6:2 FTS*	6:2 fluorotelomersulfonate
8:2 FTS	8:2 fluorotelomersulfonate
FOSA*	perflourooctanesulfonamide
brPFDA	3,7-dimethyl perfluorooctanoic acid (branched perfluorodecanoic acid)

*Also as ^{13}C labelled ISTD

PFASs analysis results

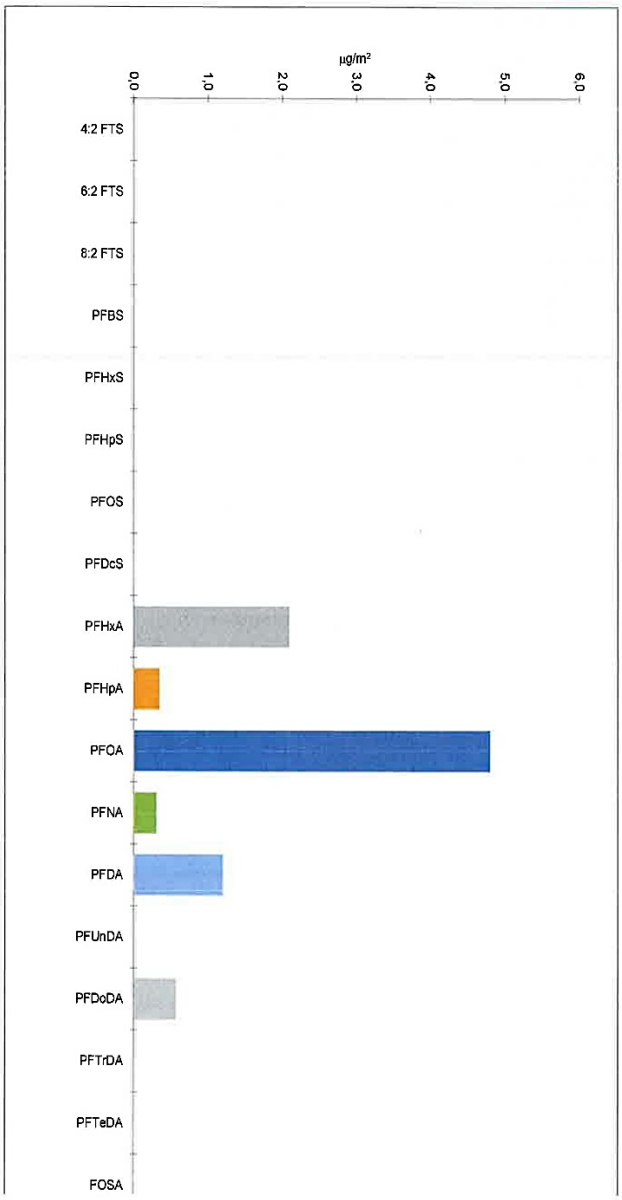
Appendix to report: T-277
NILU sample number: 1
Customer: Miljødirektoratet
Customers sample ID: Jakke, dame
Type of sample: Jakke
Sample amount (g): 2,78
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**<0.15**
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	**PFBS**	**<0.03**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,00***
Perfluorohexanoate	**PFHxA**	**2,09**
Perfluoroheptanoate	**PFHpA**	**0,349**
Perfluorooctanoate	**PFOA**	**4,80**
Perfluorononanoate	**PFNA**	**0,303**
Perfluorodecanoate	**PFDA**	**1,19**
Perfluoroundecanoate	**PFUnDA**	**<0.15**
Perfluorododecanoate	**PFDoDA**	**0,570**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***9,3***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 1



PFASs analysis results

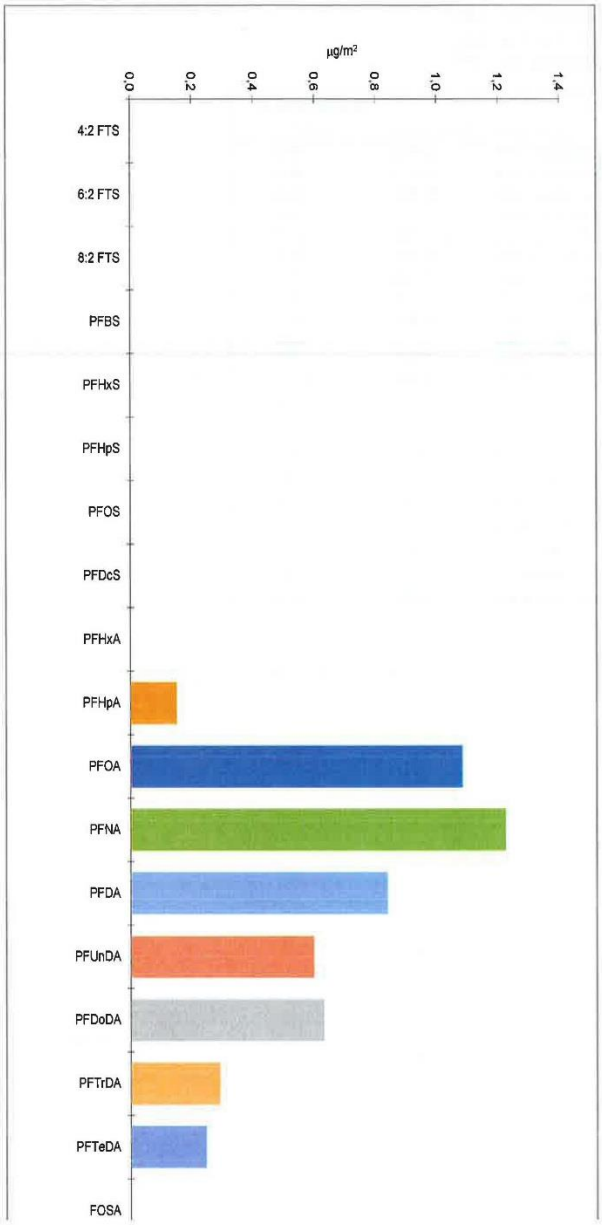
Appendix to report: T-277
NILU sample number: 2
Customer: Miljødirektoratet
Customers sample ID: Jakke, barn
Type of sample: Jakke
Sample amount (g): 1,28
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	<0.15
Sum-FTS and FTCAs		*0,00*
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		*0,00*
Perfluorohexanoate	PFHxA	<0.6
Perfluoroheptanoate	PFHpA	0,150
Perfluorooctanoate	PFOA	1,08
Perfluorononanoate	PFNA	1,22
Perfluorodecanoate	PFDA	0,836
Perfluoroundecanoate	PFUnDA	0,597
Perfluorododecanoate	PFDoDA	0,630
Perfluorotridecanoate	PFTrDA	0,290
Perfluorotetradecanoate	PFTeDA	0,244
Sum-PFCA		*5,1*
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 2



PFASs analysis results

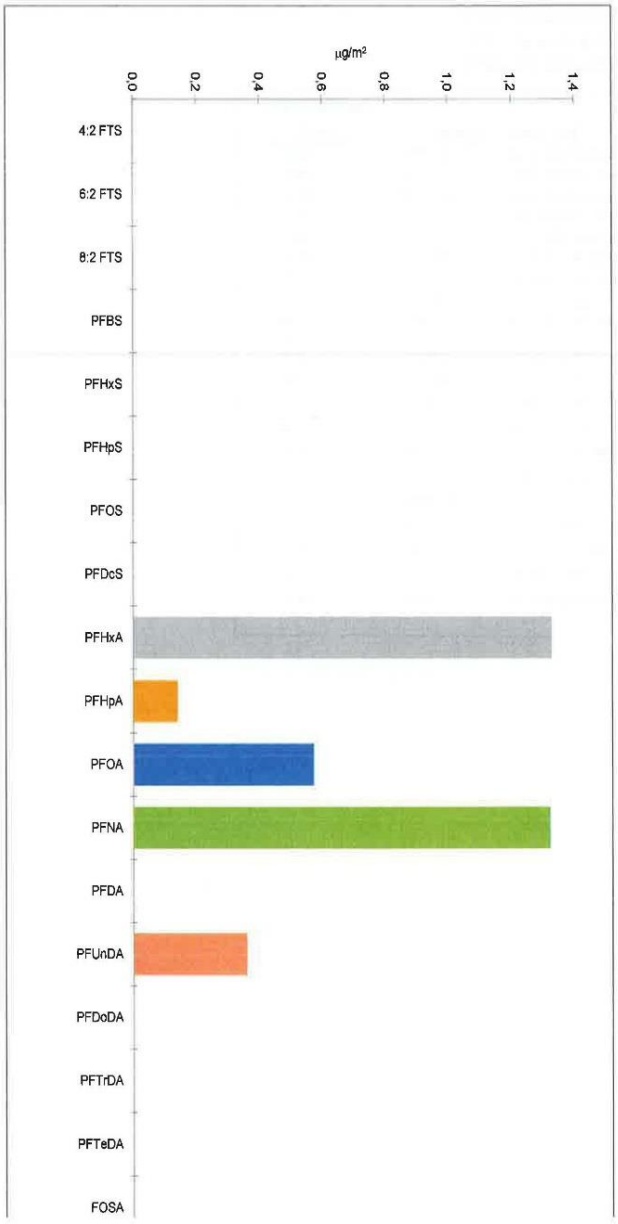
Appendix to report: T-277
NILU sample number: 3
Customer: Miljødirektoratet
Customers sample ID: Jakke
Type of sample: Jakke
Sample amount (g): 1,73
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	<0.15
Sum-FTS and FTCAs		*0,00*
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		*0,00*
Perfluorohexanoate	PFHxA	1,33
Perfluoroheptanoate	PFHpA	0,141
Perfluorooctanoate	PFOA	0,570
Perfluorononanoate	PFNA	1,32
Perfluorodecanoate	PFDA	<0.15
Perfluoroundecanoate	PFUnDA	0,360
Perfluorododecanoate	PFDoDA	<0.09
Perfluorotridecanoate	PFTrDA	<0.05
Perfluorotetradecanoate	PFTeDA	<0.09
Sum-PFCA		*3,7*
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 3



PFASs analysis results

Appendix to report: T-277
NILU sample number: 4
Customer: Miljødirektoratet
Customers sample ID: Bukse, dame
Type of sample: Bukse
Sample amount (g): 2,19
Measuring unit: µg/m^2

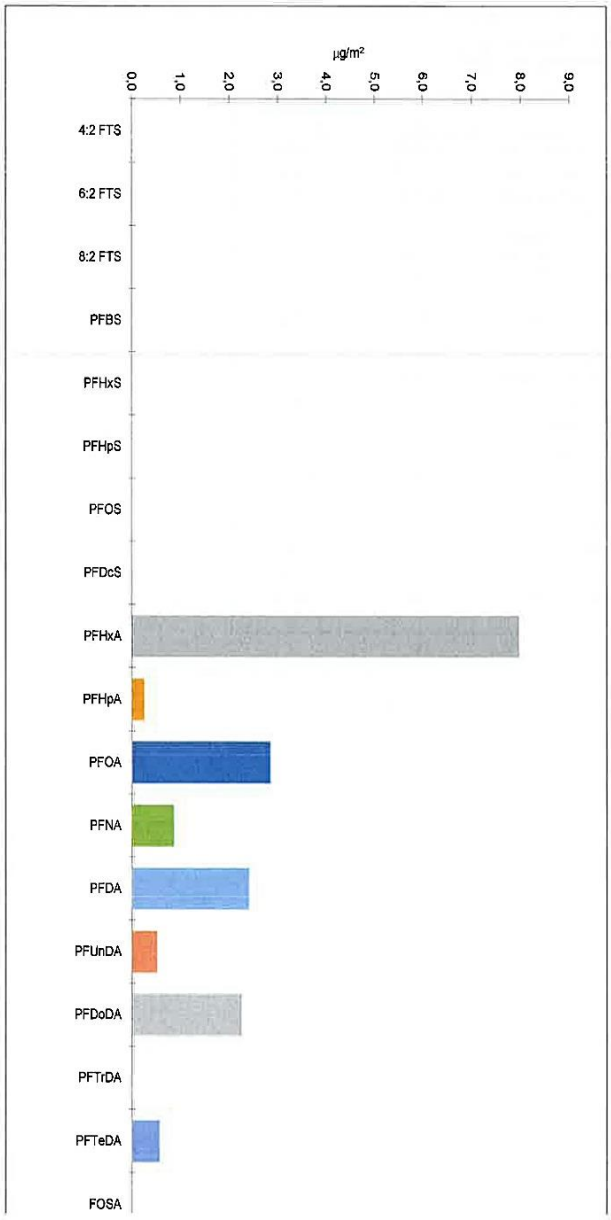
Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	<0.15
Sum-FTS and FTCAs		*0,00*
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		*0,00*
Perfluorohexanoate	PFHxA	7,97
Perfluoroheptanoate	PFHpA	0,261
Perfluorooctanoate	PFOA	2,83
Perfluorononanoate	PFNA	0,856
Perfluorodecanoate	PFDA	2,39
Perfluoroundecanoate	PFUnDA	0,526
Perfluorododecanoate	PFDoDA	2,25
Perfluorotridecanoate	PFTrDA	<0.05
Perfluorotetradecanoate	PFTeDA	0,565
Sum-PFCA		*17,6*
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

NILU

FAS analysis results

Appendix to report: T-277
NILU sample number: 4



PFASs analysis results

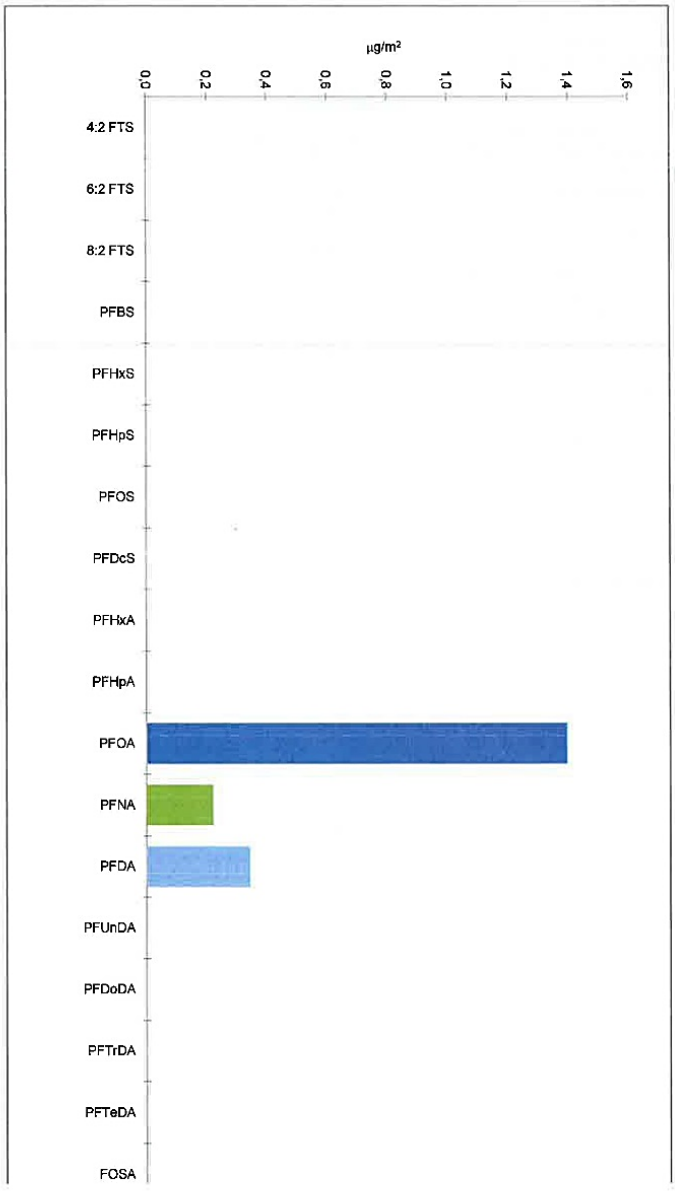
Appendix to report: T-277
NILU sample number: 5
Customer: Miljødirektoratet
Customers sample ID: Jakke, Unisex
Type of sample: Jakke
Sample amount (g): 2,02
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**<0.15**
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	**PFBS**	**<0.03**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,00***
Perfluorohexanoate	**PFHxA**	**<0.60**
Perfluoroheptanoate	**PFHpA**	**<0.06**
Perfluorooctanoate	**PFOA**	**1,39**
Perfluorononanoate	**PFNA**	**0,219**
Perfluorodecanoate	**PFDA**	**0,340**
Perfluoroundecanoate	**PFUnDA**	**<0.15**
Perfluorododecanoate	**PFDoDA**	**<0.09**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***2,0***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 5



PFASs analysis results

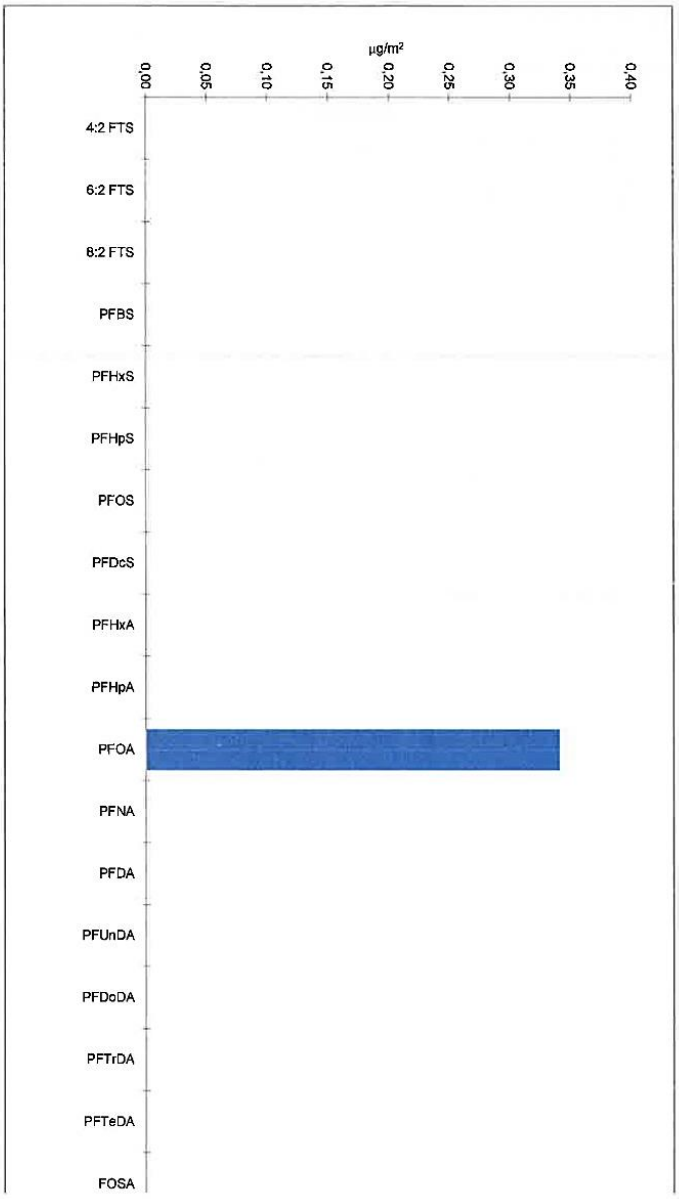
Appendix to report: T-277
NILU sample number: 6
Customer: Miljødirektoratet
Customers sample ID: Bukse, herre
Type of sample: Bukse
Sample amount (g): 2,6
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**<0.15**
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	**PFBS**	**<0.03**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,00***
Perfluorohexanoate	**PFHxA**	**<0.60**
Perfluoroheptanoate	**PFHpA**	**<0.06**
Perfluorooctanoate	**PFOA**	**0,340**
Perfluorononanoate	**PFNA**	**<0.15**
Perfluorodecanoate	**PFDA**	**<0.15**
Perfluoroundecanoate	**PFUnDA**	**<0.15**
Perfluorododecanoate	**PFDoDA**	**<0.09**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***0,3***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 6



PFASs analysis results

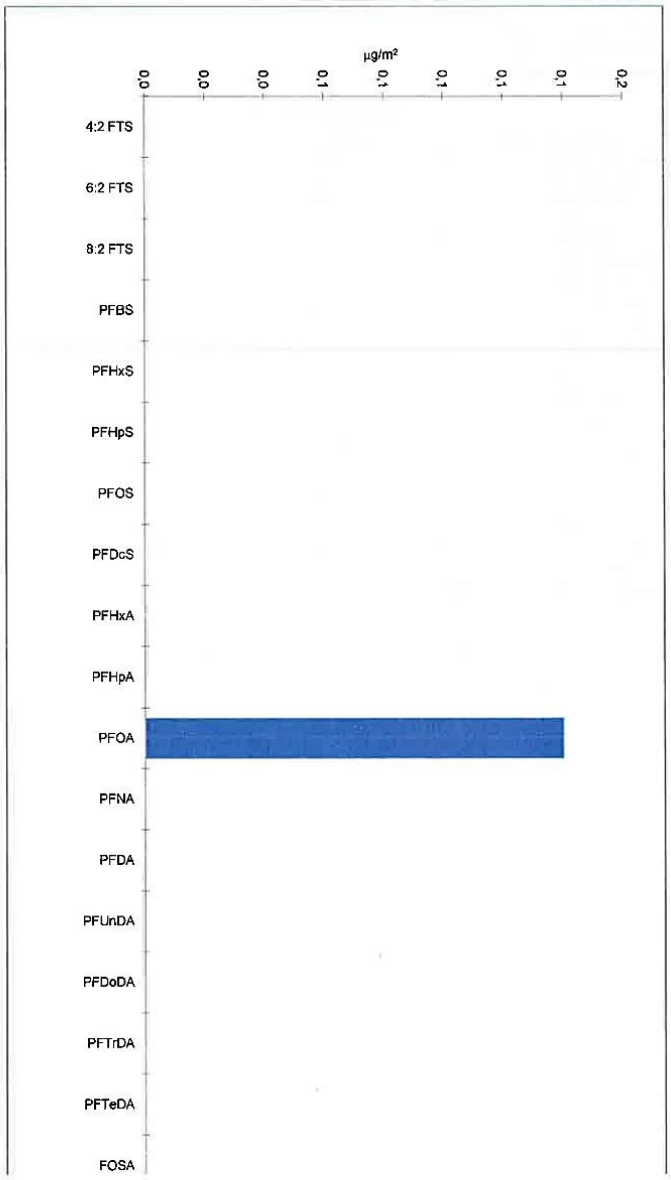
Appendix to report: T-277
NILU sample number: 7
Customer: Miljødirektoratet
Customers sample ID: Jakke, ungdom
Type of sample: Jakke
Sample amount (g): 1,71
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	<0.15
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		***0,00***
Perfluorohexanoate	PFHxA	<0.60
Perfluoroheptanoate	PFHpA	<0.06
Perfluorooctanoate	PFOA	0,14
Perfluorononanoate	PFNA	<0.15
Perfluorodecanoate	PFDA	<0.15
Perfluoroundecanoate	PFUnDA	<0.15
Perfluorododecanoate	PFDoDA	<0.09
Perfluorotridecanoate	PFTrDA	<0.05
Perfluorotetradecanoate	PFTeDA	<0.09
Sum-PFCA		***0,1***
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 7



PFASs analysis results

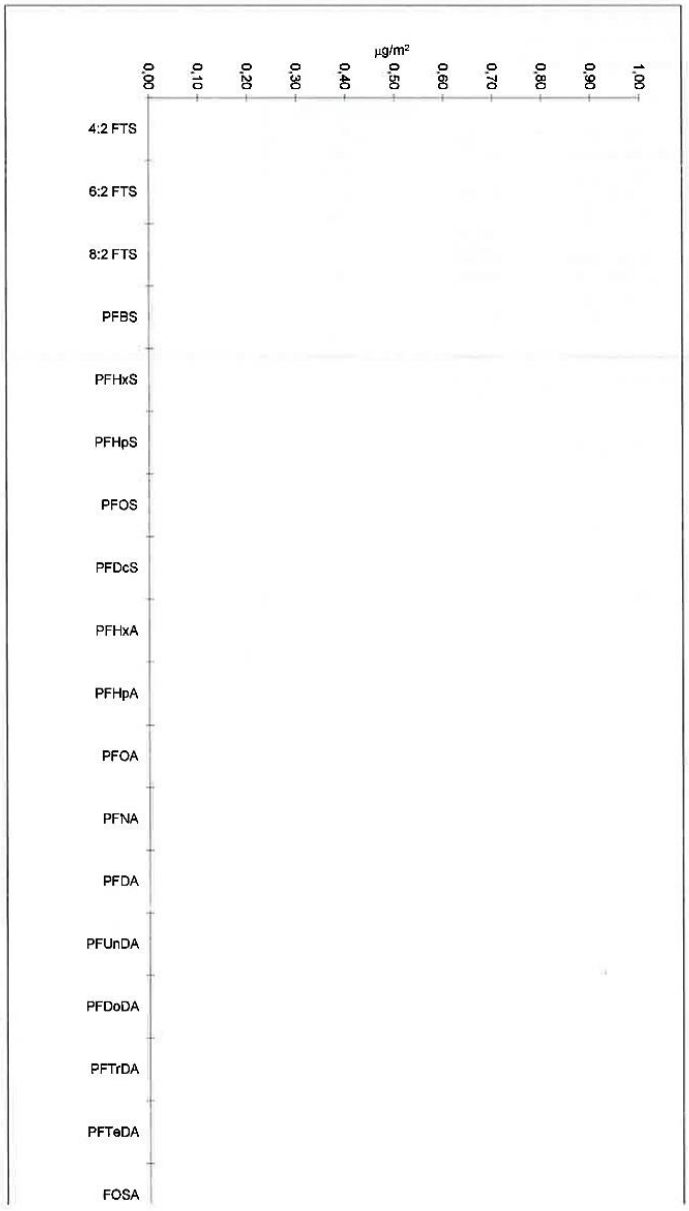
Appendix to report: T-277
NILU sample number: 8
Customer: Miljødirektoratet
Customers sample ID: Jakke, vattert, barn
Type of sample: Jakke
Sample amount (g): 0,38
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**<0.15**
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	**PFBS**	**<0.03**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,00***
Perfluorohexanoate	**PFHxA**	**<0.60**
Perfluoroheptanoate	**PFHpA**	**<0.06**
Perfluorooctanoate	**PFOA**	**<0.06**
Perfluorononanoate	**PFNA**	**<0.15**
Perfluorodecanoate	**PFDA**	**<0.15**
Perfluoroundecanoate	**PFUnDA**	**<0.15**
Perfluorododecanoate	**PFDoDA**	**<0.09**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***0,0***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 8



PFASs analysis results

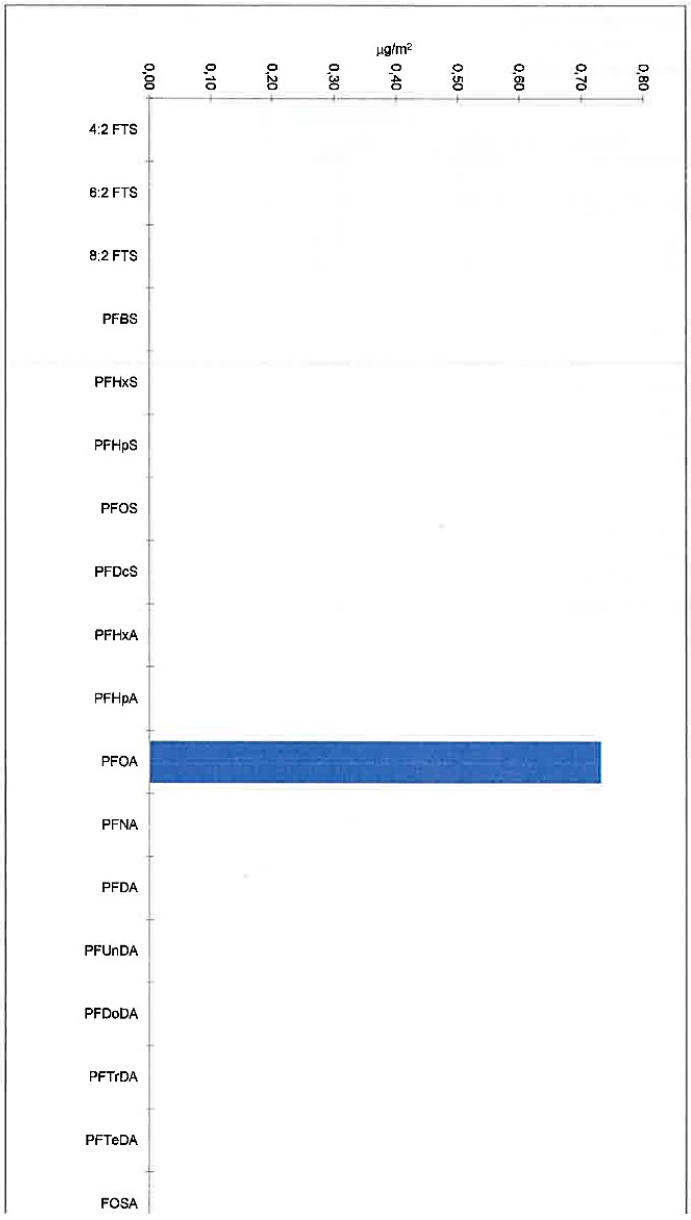
Appendix to report: T-277
NILU sample number: 9
Customer: Miljødirektoratet
Customers sample ID: Bukse
Type of sample: Jakke
Sample amount (g): 1,78
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	<0.15
Sum-FTS and FTCAs		*0,00*
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		*0,00*
Perfluorohexanoate	PFHxA	<0.60
Perfluoroheptanoate	PFHpA	<0.06
Perfluorooctanoate	PFOA	0,730
Perfluorononanoate	PFNA	<0.15
Perfluorodecanoate	PFDA	<0.15
Perfluoroundecanoate	PFUnDA	<0.15
Perfluorododecanoate	PFDoDA	<0.09
Perfluorotridecanoate	PFTrDA	<0.05
Perfluorotetradecanoate	PFTeDA	<0.09
Sum-PFCA		*0,7*
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 9



PFASs analysis results

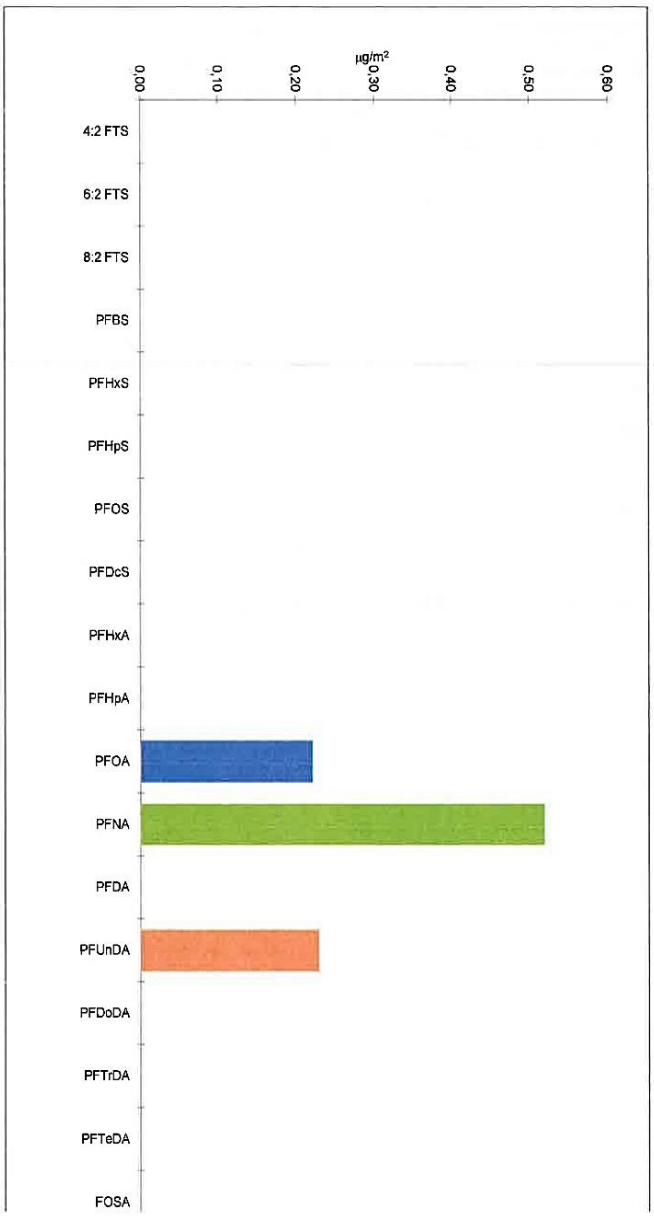
Appendix to report: T-277
NILU sample number: 10
Customer: Miljødirektoratet
Customers sample ID: Jakke, dame
Type of sample: Jakke
Sample amount (g): 1,16
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**<0.15**
Sum-FTS and FTCAs		***0,00***
Perfluorobutane sulfonate	**PFBS**	**<0.03**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,00***
Perfluorohexanoate	**PFHxA**	**<0.60**
Perfluoroheptanoate	**PFHpA**	**<0.06**
Perfluorooctanoate	**PFOA**	**0,220**
Perfluorononanoate	**PFNA**	**0,518**
Perfluorodecanoate	**PFDA**	**<0.15**
Perfluoroundecanoate	**PFUnDA**	**0,229**
Perfluorododecanoate	**PFDoDA**	**<0.09**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***1,0***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 10



PFASs analysis results

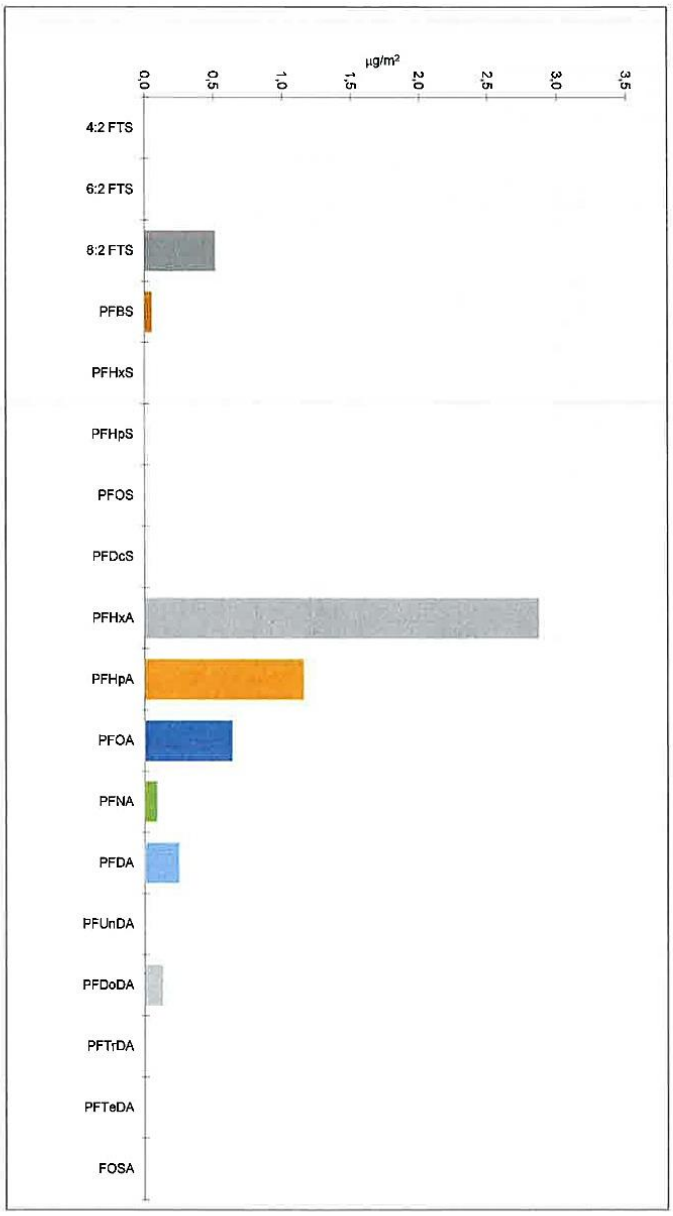
Appendix to report: T-277
NILU sample number: 11
Customer: Miljødirektoratet
Customers sample ID: Jakke, dame
Type of sample: Jakke
Sample amount (g): 1,09
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	**4:2 FTS**	**<0.03**
6:2 Fluorotelomer sulfonic acid	**6:2 FTS**	**<0.03**
8:2 Fluorotelomer sulfonic acid	**8:2 FTS**	**0,514**
Sum-FTS and FTCAs		***0,51***
Perfluorobutane sulfonate	**PFBS**	**0,055**
Perfluorohexane sulfonate	**PFHxS**	**<0.15**
Perfluoroheptane sulfonate	**PFHpS**	**<0.15**
Perfluorooctane sulfonate	**PFOS**	**<0.15**
Perfluorodecane sulfonate	**PFDcS**	**<0.30**
Sum-PFSA		***0,05***
Perfluorohexanoate	**PFHxA**	**2,87**
Perfluoroheptanoate	**PFHpA**	**1,15**
Perfluorooctanoate	**PFOA**	**0,630**
Perfluorononanoate	**PFNA**	**0,084**
Perfluorodecanoate	**PFDA**	**0,243**
Perfluoroundecanoate	**PFUnDA**	**<0.15**
Perfluorododecanoate	**PFDoDA**	**0,127**
Perfluorotridecanoate	**PFTrDA**	**<0.05**
Perfluorotetradecanoate	**PFTeDA**	**<0.09**
Sum-PFCA		***5,1***
Perfluorooctane sulfonamide	**FOSA**	**<0.15**

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 11



PFASs analysis results

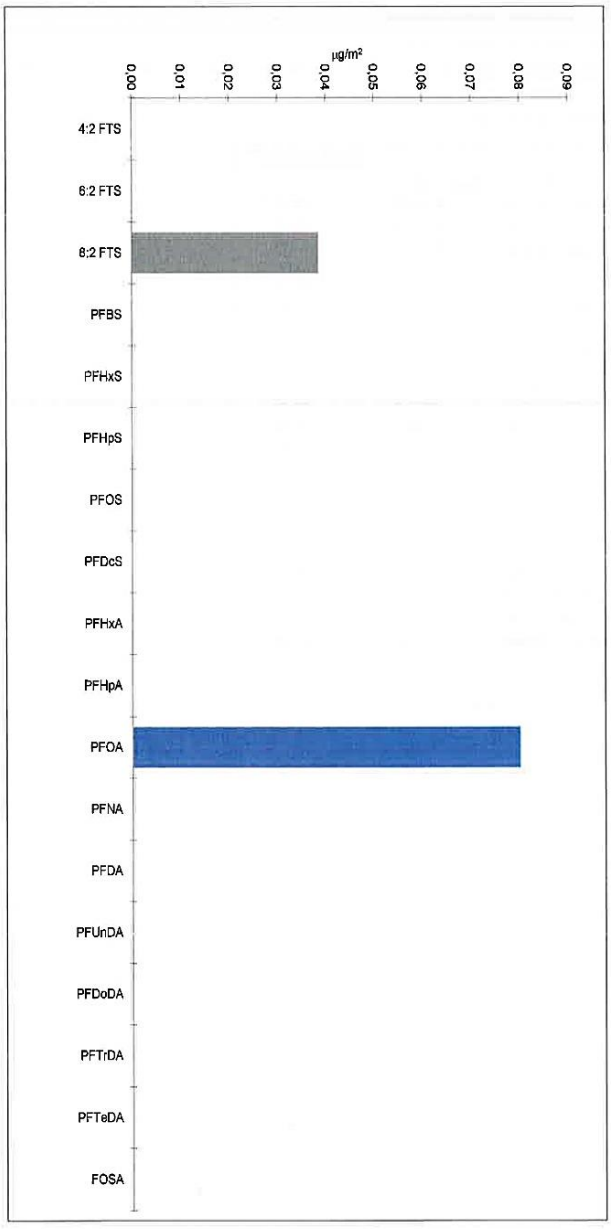
Appendix to report: T-277
NILU sample number: 12
Customer: Miljødirektoratet
Customers sample ID: Jakke, ekstra
Type of sample: Jakke
Sample amount (g): 1,57
Measuring unit: µg/m^2

Compound		Concentration
Full name	Abbreviation	µg/m^2
4:2 Fluorotelomer sulfonic acid	4:2 FTS	<0.03
6:2 Fluorotelomer sulfonic acid	6:2 FTS	<0.03
8:2 Fluorotelomer sulfonic acid	8:2 FTS	0,039
Sum-FTS and FTCAs		*0,04*
Perfluorobutane sulfonate	PFBS	<0.03
Perfluorohexane sulfonate	PFHxS	<0.15
Perfluoroheptane sulfonate	PFHpS	<0.15
Perfluorooctane sulfonate	PFOS	<0.15
Perfluorodecane sulfonate	PFDcS	<0.30
Sum-PFSA		*0,00*
Perfluorohexanoate	PFHxA	<0.60
Perfluoroheptanoate	PFHpA	<0.06
Perfluorooctanoate	PFOA	0,080
Perfluorononanoate	PFNA	<0.15
Perfluorodecanoate	PFDA	<0.15
Perfluoroundecanoate	PFUnDA	<0.15
Perfluorododecanoate	PFDoDA	<0.09
Perfluorotridecanoate	PFTrDA	<0.05
Perfluorotetradecanoate	PFTeDA	<0.09
Sum-PFCA		*0,1*
Perfluorooctane sulfonamide	FOSA	<0.15

<: Lower than indicated method detection limit (signal:noise 3:1)

FAS analysis results

Appendix to report: T-277
NILU sample number: 12



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TITLE	PROJECT LEADER
Investigation of outdoor textiles with respect to determine the content of ionic perfluorinated substances (PFAS) Evaluation of results	Linda Hanssen
	NILU PROJECT NO. O-114088
AUTHOR(S) Linda Hanssen, Dorte Herzke	CLASSIFICATION * B
	CONTRACT REF. Audun Heggelund

QUALITY CONTROLLER:

REPORT PREPARED FOR
Norwegian Environment Agency, v/Audun Heggelund

ABSTRACT
NILU has on behalf of the Norwegian Environment Agency determined the concentration of ionic perfluorinated substances (PFASs), including PFOA, in outdoor clothing. Of the investigated 12 items, no PFAS could be detected at all in only 2 of them (sample 8 and 12). Four samples contained PFOA exceeding the limit of 1 µg/m². The quality assurance where three replicates of one sample were extracted had a relative standard deviation (RSD) less than 10% for all detected substances except one (PFTrDA). Other quality measures such as recovery calculations and blanks shows that the method used for extraction is suitable for these types of matrices and substances. PFOS was not present in the items investigated, indicating that the textile industry manages to effectively avoid PFOS in their production processes.

NORWEGIAN TITLE

Undersøkelse av innholdet av ioniske perfluorerte forbindelser i tekstiler for utendørsbruk. Evaluering av resultater

KEYWORDS		
PFOA	Textiles	Quality Assurance

ABSTRACT (in Norwegian)
[Skriv abstract på norsk]

** Classification*
A Unclassified (can be ordered from NILU)
B Restricted distribution
C Classified (not to be distributed)

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