Report summary TULAC (Textiles, Upholstery, Leather, Apparel and Carpets)

Contents

1. Uses / Applications

The textile industry (Textiles, Upholstery, Leather, Apparel and Carpets so called TULAC) is one of the most extensive users of PFAS. PFAS are used both directly in textile production as well as in mixtures in the production of textile impregnating agents. The main TULAC categories inclue Home textiles, Consumer apparel and accessories, Professional apparel, Technical textiles, and Leather. The key properties provided by PFAS in these applications are water and oil repellence. In additon, fluoropolymers (e.g. PTFE) is used across multiple TULAC sectors due to their specific functions being chemical inertness (protection clothing), hydrophobicity (protection and outdoor clothing) and water vapour permeability.

2. Main PFAS substances

A variety of PFAS (non-polymer PFAS, fluoropolymers and side-chain fluorinated polymers) are in use for TULAC applications. Around 120 substances (82 of which had CAS numbers and many polymers were reported without a CAS) are identified in TULAC sector which are used intentionally or are the product of degradation or an impurity. The majority of substances reportedly used in TULAC sector in the EEA are fluoropolymers (particularly PTFE) and to some extent side-chain fluorinated polymers. Notably, all the substances reported to be used in professional textiles were PTFE or fluoropolymers of >20 carbon chain length, whereas in all the other use categories a broader array of chain length PFAS are currently reported to be used. The list of PFAS used in this sector is not provided here due to confidential Business Information (CBI).

3. Tonnage band

These estimates are based on the information gathered in the first round of call for evidence.

It is estimated that between 41,000 (low estimate) and 143,000 tons (high estimate) of PFAS are used within TULAC products in the EEA annually. It seems based on the existing quantity data of PFAS, that the "low estimate" appears to be the more credible estimate of quantities of PFAS in the EEA. There is however some uncertainty regarding how well quantaties of PFAS in imported TULAC articles are covered by these estimates.The estimated tonnages of PFAS in different applications is reported in Table 1. The key dominant TULAC sectors using PFAS are consumer apparel, followed by home textiles and technical textiles.[1] Around 80 percent of the estimated total tonnage is fluoropolymers.

The reported concentration ranges for PFAS for the TULAC categories is summerised in Appendix II. However, limited information is available on the concentrations of PFAS substances in a range of textile products.

[1] Note that tonnages reported in the Call for Evidence for several use categories have been split equally across the uses when there is no other information.

Table 1. Tonnages of PFAS estimated to be used in Textile industry

<table>
<tr><th></th><th></th><th>Total (TULAC)</th><th colspan="3">(1)
Home textiles</th><th colspan="3">(2)
Consumer apparel</th><th colspan="2">(3)
Professional apparel</th><th colspan="3">(4)
Technical textiles</th><th>(5)
Leather</th><th colspan="2">(6)
Other</th></tr>
<tr><td></td><td></td><td></td><td>(1a) Carpets and rugs</td><td>(1b) Curtains</td><td>(1c) Upholstery</td><td>(2a) Indoor and Outdoor wear</td><td>(2b) Sports wear</td><td>(2c) Footwear</td><td>(3a) Professional sports wear and footwear</td><td>(3b) PPE for industrial applications</td><td>(4a) Outdoor technical textiles</td><td>(4b) High performance membranes</td><td>(4c) Medical applications[2]</td><td></td><td>(6a) Home fabric treatments – leather</td><td>(6b) Home fabric treatments – textiles</td></tr>
<tr><td rowspan="2">Total non-polymer PFAS</td><td>low</td><td>5,662 (14%)</td><td colspan="3">1,079 (17%)</td><td colspan="3">1,079 (13%)</td><td colspan="2">1 (0%)</td><td colspan="2">1,080 (17%)</td><td>0</td><td>-</td><td colspan="2">2,422 (16%)</td></tr>
<tr><td>high</td><td>18,913 (13%)</td><td colspan="3">4,203 (15%)</td><td colspan="3">4204 (9%)</td><td colspan="2">101 (1%)</td><td colspan="2">4,303 (16%)</td><td>0</td><td>-</td><td colspan="2">6,103 (30%)</td></tr>
<tr><td rowspan="2">Total fluoropolymers</td><td>low</td><td>33,092 (80%)</td><td colspan="3">4,920 (79%)</td><td colspan="3">6,062 (74%)</td><td colspan="2">5,119 (98%)</td><td colspan="2">5,107 (82%)</td><td>331 (100%)</td><td>-</td><td colspan="2">11,553 (77%)</td></tr>
<tr><td>high</td><td>109,544 (77%)</td><td colspan="3">22,606 (83%)</td><td colspan="3">32,910 (70%)</td><td colspan="2">18,943 (95%)</td><td colspan="2">22,217 (84%)</td><td>1,095 (100%)</td><td>-</td><td colspan="2">11,773 (57%)</td></tr>
<tr><td rowspan="2">Total side-chain fluorinated polymers</td><td>low</td><td>2,430 (6%)</td><td colspan="3">230 (4%)</td><td colspan="3">1,019 (12%)</td><td colspan="2">100 (2%)</td><td colspan="2">14 (0%)</td><td>0</td><td>-</td><td colspan="2">1,067 (7%)</td></tr>
<tr><td>high</td><td>14,236 (10%)</td><td colspan="3">559 (2%)</td><td colspan="3">10,034 (21%)</td><td colspan="2">1,000 (5%)</td><td colspan="2">22 (0%)</td><td>0</td><td>-</td><td colspan="2">2,621 (13%)</td></tr>
<tr><td rowspan="2">Total</td><td>low</td><td>41,183</td><td colspan="3">6,230</td><td colspan="3">8,161</td><td colspan="2">5,220</td><td colspan="2">6,201</td><td>331</td><td>-</td><td colspan="2">15,041</td></tr>
<tr><td>high</td><td>142,692</td><td colspan="3">27,368</td><td colspan="3">47,148</td><td colspan="2">20,044</td><td colspan="2">26,541</td><td>1,095</td><td>-</td><td colspan="2">20,496</td></tr>
</table>

[2] Medical devices are covered by a separate summary report. To maintain clarity, medical textiles used in this report refers to any use of textiles in a medical setting, excluding use within or on the patient (i.e., implantable textiles like gauzes or applications used upon the body like bandages are included under medical devices). As examples of the textiles included within the current definition this could extend to articles such as mattress protectors upon hospital beds, curtains/drapes around the bed, and gowns / PPE used by medical professionals.

4. Import & Export

In 2017, the EEA produced 7.4 kg of textiles per person while consuming nearly 26 kg which equates to ~12 million tonnes consumed in the EEA based on the current population. Therefore, a large proportion of textiles within the EEA are imported (90 percent of the textiles used in the EEA are manufactured outside of the EEA) especially in the technical textile and 'clothing' categories (mainly finished products from Asia). The exact use/ consumption of different types of garment is not quantified for the EU28 and no data was provided during the CfE. From the EURATEX data for 2017-2018, the amount of 4.6 million tonnes of textiles within the EEA are imported with main contribution from Consumer apparel, primarily Indoor and Outdoor wear. Overall, the main categories of TULAC sold and imported to the EEA include Home, consumer and technical textiles. Only 1.2 million tonnes of textile are exported with a main contribution from consumer apparel. In general, very little data is available on the quantity of clothing both imported and exported for professional apparel and leather. The quantitative data obtained from the EURATEX data for 2017-2018 on import, export and sold quantity of textile in Europe is summarised in Appendix I.

5. Manufacturing & Market price + market development

There has been a decrease over the last 5-10 years in the use of PFAS within the consumer sector due to voluntary initiatives to move away from PFAS and due to increasing regulatory pressure on C6. Alternatively there are TULAC sectors that are seeing an increase in the market sales of their products and this includes areas such as outdoor textiles (awnings/roofs) and outdoor furniture, but also PPE. Given the current impacts of COVID-19 on PPE use increases in the tonnage of PPE products produced and used in the EEA is expected. Where market trend data has not been identified a uniform growth rate of 2% per annum is applied.

In the EEA, there are around 171 000 companies operating in the textile (including wearing apparel) industry, employing 1.7 million people. The number of companies dealing with articles containing PFAS has not been identified.

6. Emissions

In general, major life-cycle stages are broadly disaggregated into three stages that covers the production stage (including manufacture of components and mixtures, and textile treating), the 'in-use ' stage, and the waste stage.

In total, the emissions of PFAS in 2020 from the different use cathegories by life-cycle stage were as follows:

Non-polymer PFAS :	1,111-3,925 tonnes/a
Fluoropolymers:	3,347-10,561 tonnes/a
Side-chain fluorinated polymers:	475-3,617 tonnes/a

The overview of the estimated EEA yearly emissions for 2020 is shown in Table 2 based on the receiving environment and in Table 3 by life-cycle stage.

Based on the material flow and assignment of ERC emission factors, the air compartment is the primary pathway, with soil and then water as secondary pathways.

Table 2.1 Overview of estimated yearly EEA emissions for 2020 (baseline) by receiving environment (all values in tonnes per annum)

PFAS grouping	Quantity in use EEA (tonnes)	Emissions to air (tonnes)	Emissions to water (tonnes)	Emissions to soil (tonnes)	Total emissions (all vectors) (tonnes)	Proportion of the emission to quantity used (%)
TOTAL Non-polymer PFAS- Low estimate	5,662	728	57	326	1,111	20%
TOTAL Non-polymer PFAS- High estimate	18,913	2,657	183	1,085	3,925	21%
TOTAL Fluoropolymers - Low estimate	33,091	1,456	385	1,506	3,347	10%
TOTAL Fluoropolymers - High estimate	109,544	4,564	1,204	4,793	10,561	10%
Side-chain fluorinated polymers- Low estimate	2,430	320	33	122	475	20%
Side-chain fluorinated polymers- High estimate	14,236	2,663	218	736	3,617	25%

For non-polymer PFAS the primary release point to environment (key life-cycle stages for emission) is either during the treatment of textiles with PFAS mixtures, or from the in-use phase for indoors textiles or leather articles subject that are subject to frequent cleaning/washing and so have higher potential for release.

Overall, the combined manufacture of commercial mixtures and treating of textiles as a finishing step may be more emissive to the environment than the manufacture of non-woven membranes.

Table 3. Overview of estimated yearly EEA emissions for 2020 (baseline) by life-cycle stage (all values in tonnes per annum)

PFAS grouping	Quantity in use EEA	Manufacture of non-woven membranes	Manufacture of mixtures for textile treatment	Processing aids	Textile treating	Group 1 – Indoor frequent cleaning – In use	Group 2 – Indoor infrequent cleaning – In use	Group 3 – Outdoor – low release – In use	Total emissions
TOTAL Non-polymer PFAS- Low estimate	5,662	n.a.	141	0.06	536	317	1	115	1,111
TOTAL Non-polymer PFAS- High estimate	18,913	n.a.	473	0.08	1,800	1,280	4	368	3,925
TOTAL Fluoropolymers - Low estimate	33,091	1,011	323	n.a.	1,229	3	5	776	3,347
TOTAL Fluoropolymers - High estimate	109,544	3,616	934	n.a.	3,555	13	16	2,426	10,561
Side-chain fluorinated polymers-Low estimate	2,430	61	30	n.a.	116	*201*	0.3	67	475
Side-chain fluorinated polymers- High estimate	14,236	356	179	n.a	680	*1,963*	0.8	439	3,617

It seems based on the existing quantity data of PFAS, the "low estimate" appears to be the more credible estimate of quantities of PFAS in the EU / EEA.

7. Past & future emissions

The full time-series for TULAC (1990 - 2050) in usage and emissions of PFAS in is presented in Appendix III.

Figure 1 below provides the outputs of the emission estimate time-series (for the low end of the market data range). This provides emissions of PFAS (non-polymeric, fluoropolymers and side-chain fluorinated polymers) to the environment as the aggregated totals to all vectors (air, soil, and water). Based on the assumptions for growth trends applied to the different textile application types (see above), the estimates show across the entire time-series (1990 – 2050) an increasing trend in emissions. This is linked to the strong and continued demand for PFAS since its commercialisation in the 1950s. Based on the emission estimates and projections, the emission estimates for the baseline year of 2020 can be expected to broadly double by the year 2050 assuming a business-as-usual scenario. Use of fluoropolymers, and related emissions, are assumed to more than double while emissions from use of non-polymeric PFAS and side-chain fluorinated polymers are assumed to grow at a slower rate.

Overall, since user patterns of various PFAS change over time, such as the transition from long chain PFAS to short chain PFAS around 2012, it is challenging or not even possible to compare historical quantities and future projection data, and in particular for data of groups of non-polymer PFAS.

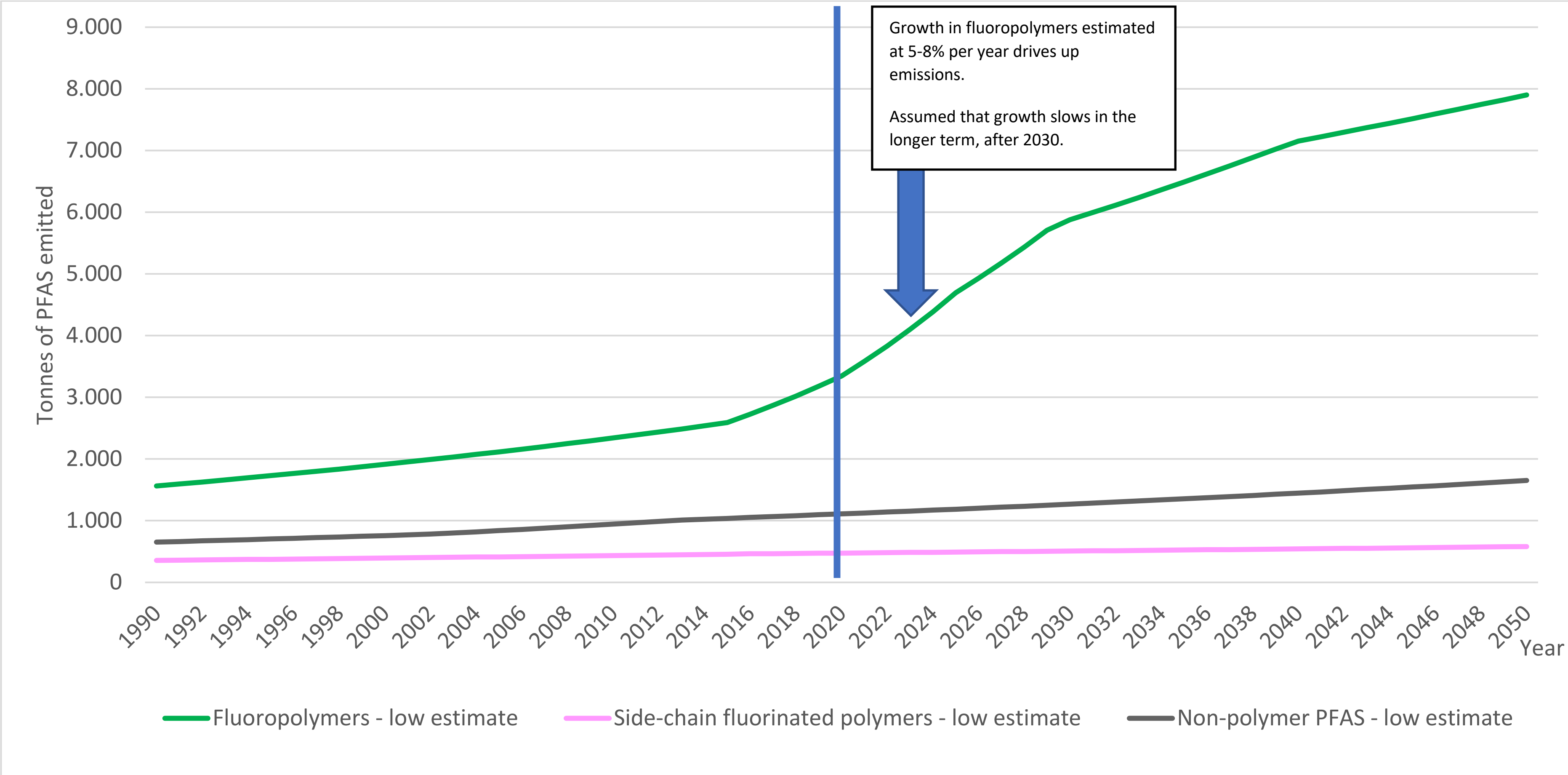

Figure 1. Emission estimate projections 1990-2050 for PFAS (all groups) to environment as tonnes per annum

8. Summary of existing legal requirements

The chemical regulations are harmonised within the EEA, EEA regulations (particularly the REACH regulation) are the most important and effective instruments for the authorities to manage PFAS. In addition, in some EEA nations, for example, in Sweden, Denmark, and Norway regulations and other measurements are in place, or are being considered, that would go beyond solely the implementation of EEA legislation. Some industry measures also were taken to move away from PFAS in the coming years. For instance over 30 brands in fashion, makeup and retail have joined "the PFAS Movement". The brands that have joined the movement commit to end all non-essential PFAS uses in products and supply chains.

9. Alternatives

The main properties to be provided by alternatives are : water repellency, durability and stain repellency. Those use categories that require functionality beyond water repellency do not currently appear to have a viable alternative available. Previously published information indicates that ~200 fluorine-free alternatives are produced by more than 10 different companies globally, however these focus almost entirely on providing water repellency.

Possible alternatives mainly for consumer and home textiles:

1. Chemical categories (source: literature & SDS sheets)

Hydrocarbons, Silicones, Polyurethane, Non-ionic Polymer, Ester Compound, Naphtha (petroleum), hydrotreated heavy, Organic Solvent and Water, Paraffin, Alcohols, C12-16, ethoxylated (>5-15 EO), Carnauba wax, Acrylate copolymer, Formulations based on paraffins (Paraffin oils), Modified melamine resins, Plant seed oil, bio based product, emulsion containing aluminum, Polyethylene Oxide Mono-C12-16-Alkyl Ether, Dendrimers, Aminofunctional PDMS, Sodium methylsiliconate water, Potassium methylsiliconate, Isobutyltrimethoxy silane, Octylsilane, Hexyltriethoxysilane, Blend of n-octyltriethoxysilane and reactive silicone, Octyltrimethoxysilane-based, Methoxy terminated silsesquixanes, Emulsion of polydimethylsiloxane, Polysiloxane and polyester, Polysiloxane and polyester, Alkyl polysiloxane, Aminofunctional polysiloxanes, Plasma based nano-coating, Hybrid (Silicon/Hydrocarbon), Alkyl polysiloxane solution.

2. Technical performance based on control of the surface roughness and weaving density

Dendrimers (branched 3D like hydrocarbons), Graphene structures, Nanomaterials (tend not to be used by the textile industry).

Table 4 provides an overview of the key groups of alternatives and their feasibility in relation to the major textile categories. The alternative technologies mainly provide water repellency and can be further optimised by non-fluorinated alternatives. Table 5 provides a broad comparison of the substitution potential of each of the TULAC sectors based on information gathered on potential alternatives. The main challenge in moving away from the use of PFAS in TULAC products is the development of alternatives for application areas where replacement is still challenging i.e. professional and technical textiles, PPE and medical applications. In these sectors, with existing evidence, no current alternative is available to replace PFAS which delivers the same level of performance. Whereas, for applications where only water repellency is needed, alternatives could be considered feasible.

Lower performance and lower durability effects of alternatives seem to be accepted for consumer products but no alternatives indicated for the professional, medical and technical textiles sectors. If water repellency, oil, stain and chemical repellency are needed for the performance of the products then somewhat longer transition periods (3-10 years) might be needed to allow for further development and implementation of alternatives that minimise the loss of functionality.

Table 4. Alternative substance groups, their technical and hazard properties, and indicative costs (based on information gathered in the MIDWOR project[3])

Chemical group(s)	Applicable use sector	Technical functionality	Purchasing cost (compared to PFAS technologies)
Dendrimer	Clothing and non-clothing textiles made of cotton, polyester or blends. Carpets	Can impart water repellency properties Poor oil repellency 200 - 400 % application quantity based on PFAS-based substances. Information provided by manufacturer.	Similar/ slightly more expensive Around 25 % less expensive than C8-based product. (MIDWOR project) RUCO-DRY ECO = ~10 €/kg depending on application, country, purchase quantity and customer. Information provided by manufacturer.
Hybrid (Silicone/ Hydrocarbon)	Consumer (inc. outdoor), leather, home textiles, reimpregnation sprays	High degree of water repellency Poor oil repellency Good wash durability	Similar Approximated price UNIPERL HDS ~10 €/kg. UNIPERL dosage is higher than average fluorocarbon dosage. Information provided by manufacturer.
Hydrocarbons e. g Paraffin wax	Consumer, outdoor, home textiles, carpets	Good water repellency Poor oil repellency Zelan™ R3 finish is up to 3X more durable than most existing non-fluorinated repellents. Information provided by manufacturer.	~50% lower (but require higher dosage) Zelan™ 15– 15-20 EUR/kg. Stakeholder interview[4].
Nanotechnologies	No data.	Water repellency and soil resistance	Limited data. New technology Plasmaguard Part 3 product. No increase in cost per unit on finished goods, slight increase in price on R2R deposition due to mower dispositioning speed. Less than 15% increase in unit price. Information provided by manufacturer.
Polyurethane	Clothing and non-clothing textiles, carpets	Only claim to provide water repellency	No price data available . CBI.
Silicones (e.g. PDMS)	Consumer, Leather, carpets	High degree of water repellency at relatively low concentrations No oil or soil repellency	No price data available. CBI.

[3] https://www.midwor-life.eu/

[4] Concordia Textiles

Table 5. Broad assessment of substitution potential of TULAC use sectors

Major use category	Substitution potential
Consumer apparel	Yes, as oil-repellency is not considered critical for consumer apparel (including sports, outdoor textiles). Alternative products are available in sufficient quantities to replace PFAS in this sector. Some companies are already using alternatives.
Home textiles	Partly, as oil-repellency includes also stain-repellency (when the stain is based on oil). If only water repellency is required then alternatives are available. Some companies are already using alternatives.
Professional apparel	No, the alternatives do not provide resistance against oil, chemicals, blood etc which are often required in PPE. Further research and development of alternatives is required, expected to take some years.
Technical textiles	No, the alternatives do not provide resistance against oil, chemicals, blood etc. Also, the physical durability of the treated material is suggested to be decreased with alternatives. Further research and development of alternatives is required, expected to take some years
Leather	Partly, when only water repellency is needed. In cases where oil- and stain-repellency are required then substitution is less feasible. Further development of alternatives to give oil repellency is required.
Other (Home fabric treatments (sprays) for leather/textiles)	Partly, when only water repellency is needed. In cases where oil- and stain-repellency are required then substitution is less feasible.

10. Economic impacts in case of a full PFAS ban

In general, quantitative data on economic impacts are not readily available. There are considerable data gaps in this area. Some qualitative or semi-quantitative conclusions can however be drawn.

The general impression is that for articles where PFAS primarily provide water repellency (e.g. consumer apparel) there are technically and economically feasible alternatives available. Following recent restrictions on other PFAS substances within the wider PFAS group there appears to be a general trend in the consumer sector to phase out PFAS substances and even move to fluorine-free alternatives, due to increasing pressure from the public to phase out hazardous substances. Regarding the effective price of alternatives relative to price of PFAS in these applications, consultation with manufacturers of alternatives indicate that the overall price is more or less the same. In some cases, the unit price of the fluorine-free alternatives that provide water repellency is lower but the amount required during application can be up to 50% more compared to the C6 technologies to achieve comparable water repellence. Overall, the shelf life of the alternatives does not seem to be shorter than the shelf life of PFAS-based repellents and no extra costs, as a consequence of differences in shelf life, have been indicated by stakeholders. Additionally, manufacturers of alternatives indicated that the alternative finish appears to be applied in the same way as any PFAS based treatment. Therefore, minimal additional costs related to change in equipment are anticipated but no data was provided on this aspect during the CfE. Stakeholders indicate that the alternatives require longer processing times which could affect production capacity and potentially the need for additional capital expenditure.

Substitution from PFAS to alternatives impacts the frequency of replacement. There is a higher replacement frequency in relation to PFAS-based substances because PFAS-free finishing chemicals withstand laundering much less. This could have implications which lead to more frequent replacement or re-impregnation of the articles by the user.

The uses of PFAS within high performance applications (such as professional apparel and technical textiles) are perceived to be the hardest to eliminate, particularly due to the oil repellence element. The time and cost to develop alternatives could be burdensome and expensive especially for small companies, although specific data was not available to quantify the potential costs. For some of these applications a ban on PFAS could potentially lead to inability to fullfil legal safety standards (e.g. for some PPEs) or to considerable losses in product performance and/or technical life-span.

11. Other impacts in case of a full PFAS ban

Unavailability of PFAS may contribute to a reduction in durability for some products, particularly high-performance products, potentially leading to increased waste and environmental impacts associated with increased production of new products. There is also an important human health and environmental risk considerations related to loss in functionality. The potential for increased level of exposure to chemicals and bodily fluids for example due to lower functionality (e.g. reduced oil, stain, chemical repellency) would have important implications for the overall environmental and human health impacts in protective textile sectors such as medical textiles and technical textiles/PPE.

The potential for any impacts on **employment** (including numbers of jobs, skills/qualifications required and job quality) from the proposed restriction has not been assessed.

12. Methods used & uncertainties

The use tonnages estimates are based on information submitted in the first round of call for evidence.

A basic source-flow model using the year 2020 as a baseline has been developed to make use of the data from the market analysis and substance identification nevertheless not on a substance-by-substance basis, but rather taken a grouping approach. The ECHA R.16 Environmental exposure assessment guidance, including Environmental Release Category (ERC) default emission factors are used to guide estimates. The source-flow model provides data as tonnages of PFAS (disaggregated between the different substance groups) for different application types.

Projections of the average growth rate across all six major application sectors has been derived and applied to the baseline market data from 2020 to map total usage rates from 1990 – 2020.

The same averaged growth rate has also been applied to the overall emissions from the 2020 baseline to derive annual total emission estimates from 1990 - 2020.

Table 6. Summary of assumptions and factors applied to the market data

Component	Value	Assumption and justification
Division of PFAS by production type.	C2 and C3 Non-polymeric PFAS = 100% use in mixtures. C4, C5, and C6 Non-polymeric PFAS = 100% use in mixtures. C9-C14 Non-polymeric PFAS = 100% use in mixtures. Other non-polymeric PFAS = 50% mixtures / 50% processing aids. PTFE and PVDF = 75% membranes / 25% mixtures. FEP, PFA, other fluoropolymers = 50% membranes / 50% mixtures PFPE = 100% mixtures Side-chain fluorinated polymers = 50% membranes / 50% mixtures	Assumption: C2, C3, C4, C5,C6 and C9-C14 Non-polymeric are only known to be used in mixtures based on the CfE. The other non-poly includes the processing aids. In lieu of data assume equal splits. PTFE and PVDF are predominantly used in membranes. However, PTFE micro-powder can be used in dispersions and mixtures. Expert judgement of 75/25% between membranes and mixtures. FEP, PFA, other fluoropolymers apply equal splits between membranes/mixtures. PFPEs are oils at ambient temperature, this may mean they are more likely used within mixtures than membrane technology. Assume 100% use in mixtures. Less data on side-chain fluorinated polymers, so have assumed equal split between membranes and mixtures.

Component	Value	Assumption and justification
		Justification: Data on how PFAS is used in the formulation step is more limited, but it is possible to assign market splits based on the stakeholder interviews and literature research.
Production of non-woven membranes	Apply the following emission release category (ERC) codes : ERC 12A – Processing of articles at industrial sites with low potential release. Emissions to air: 2.5%w.w Emissions to soil: 2.5% w.w Releases into wastewater system: 2.5% w.w	Assumption: Apply ERC12A to the production of membranes. Fluoropolymers are highly stable, but assume emissions relate to dusts and any cutting activities. Justification: Production of membranes involves physical manipulation processes, emissions as 'vapours' is less likely, but dusts are possible.
Production of commercial mixtures.	Apply the following emission release category (ERC) codes: ERC 2 – Formulation into mixture. Emissions to air : 2.5% w.w Emissions to soil: 0.01% w.w Releases into wastewater system: 2% w.w	Assumption: Apply the standard ERC for mixtures. Justification: There may be a variety of different mixing / blending processes going on to produce commercial mixtures, but the standard ERC should be a fair default.
Use of processing aids in the production of textiles.	Apply the following emission release category (ERC) codes : ERC 6B – Use of reactive processing aid at industrial site (no inclusion into or onto article). Emissions to air: 0.1% w.w Emissions to soil: 0.03% w.w Releases to wastewater system: 5%	Assumption: Data from the CfE suggests that use or processing aids for production of textile materials is carried out within closed systems. Have applied ERC 6B. Justification: Industry specific data for this activity are lacking. The default ERC should act as a conservative proxy.
Group 1 – Indoor use – frequent cleaning / wetting.	The European Commission study applied ERC 11b (widespread use of articles with high or intended release (indoor) to all PFAS. However, the Commission study only covers non-polymeric PFAS. In reality fluoropolymers will be very stable and unlikely to emit significant amounts during use unless abraded. Therefore: Non-polymeric PFAS and Side-chain fluorinated polymers (ERC 11b): Emissions to air: 50% Emissions to soil: 0% Releases to wastewater: 50% Fluoropolymers (ERC 11a): Emissions to air: 0.05% Emissions to soil: 0% Releases to wastewater: 0.05%	Assumptions: Follow the ERC used by the Commission study but amend for fluoropolymers. 100% release for fluoropolymers is highly unlikely. Justification: The ERC11b may be fair for non-polymeric and side-chain fluorinated polymers with frequent cleaning / washing. For fluoropolymers have selected a more appropriate ERC.
Group 2 – Indoor use – infrequent cleaning /wetting.	The European Commission study applied ERC 11a (widespread use of articles with low release (indoor) to all PFAS. Emissions to air: 0.05% Emissions to soil: 0% Releases to wastewater: 0.05%	Assumption: Have used the ERC used in the Commission study. Justification: ERC has been applied to both non-polymeric and polymeric species equally.
Group 3 – Outdoor use – low release		Assumption: Have used the ERC used in the Commission study.

Component	Value	Assumption and justification
	The European Commission study applied ERC 10a (widespread use of articles with low release (outdoor) to all PFAS. Emissions to air: 0.05% Emissions to soil: 3.2% Emissions to surface water: 3.2%	Justification: For continuity, the same ERC has been applied as in the Commission study. Note however for fluoropolymers, this will result in a worst-case scenario for emissions and may overestimate.

Uncertainties:

- There is no comprehensive production and quantity data for all known PFAS.
- The tonnage of TULAC treated with PFAS that is imported within the EEA is still an area of uncertainty given the limited details provided by stakeholders (the contribution of imported textiles to total PFAS burden in the EEA). Therefore, CfE-data could imply a considerable underestimate of total PFAS in TULAC on EU/EEA market.
- There is no information to what extent the approximately 120 PFAS are used in TULAC neither by quantity nor by function.
- Information on EEA-level production and use of alternatives is lacking for all the TULAC sectors.
- No information was provided in the CfE on the proportion of the TULAC market or uses that have switched away from using PFAS.
- Information on the tonnage of technical and professional textiles produced and used within the EEA would be beneficial.
- Comparative costs of both PFAS used for textile treatment and the comparative alternatives is a key remaining data gap.
- Limited data was received from the CfE on the costs of replacing equipment associated with switching to alternatives.
- For this particular TULAC emission estimate, production of non-polymer, side-chain fluorinated polymers and fluoropolymers and the waste phase are excluded.
- -Tonnages are based on the CfE information where total tonnage of PFAS used by a company is not always broken down specifically per use sector and some companies use PFAS for example in construction products, lubricants, food contact materials etc and have just reported total company use.
- -Lack of PFAS sector specific Environmental Release Categories (SPERCs), that correspond to sets of information describing specific good practice conditions of use and the corresponding release estimates (to water, air, soil and waste).

Appendix I

Summary of EURATEX import and export data (2018) submitted previously to COM project

TULAC Category	TULAC sub-category	Imported (t)	Exported (t)	Sold volume in the EEA (2019) (t)
(1) Home textiles	(1a) Carpets and rugs	450,657	251,333	1,568,818 *
	(1b) Curtains	123,082	9,339	161,662 *
	(1c) Upholstery	88,028	8,356	940,400 **
(2) Consumer apparel	(2a) Indoor and Outdoor wear	2,862,574	167,971	1,347,547 †
	(2b) Sports wear	79,046	427,154	45,412 †
	(2c) Footwear	-	-	-
(3) Professional apparel	(3a) Professional sports wear and footwear	-	-	-
	(3b) PPE for industrial applications	-	-	101,187 **
(4) Technical textiles	(4a) Outdoor technical textiles	859,662	270,127	582,152
	(4b) Medical applications	124,639	66,519	-
	(4c) High performance membranes	-	-	-
(5) Leather	(5a) Leather based goods	-	-	173,973 **
	(5b) Indoor and Outdoor wear	-	-	10,150 †
	(5c) Footwear	-	-	711,548‡
	(5d) Professional sports wear and footwear	-	-	-
(6) Other	(6a) Home fabric treatments – leather	-	-	-
	(6b) Home fabric treatments – textiles	-	-	-

pa = number of pairs ; p/st = number of items.

** p/st converted to kg

† mix of p/st, and pa values converted to kg

‡ pa values converted to kg

Appendix II

Working concentrations of PFAS substances in a range of textile products

Architectural textiles and tents	0.5 % in the final textile product
High performance upholstery	<0.1% C6 SCFP in final textile product
Outdoor textiles	2% of FEP/PFAA in final product
Chemical protective suits	PTFE (max 1%), THV (max 1%) or FKM or Fluorosilicone (50-90%)
Protective and technical textiles where PTFE is used as a membrane material	100% PTFE
PPE - (non medical)	1.5 - 3 %
Medical gowns, drapes and PPE	C6 concentration average for all products <0.5%
Within some face masks	1.9% of ePTFE in final products (by weight).
Leather straps	200 micrograms/m^2
Architectural polyester / PVC fabrics as fluoropolymers	<1% as a protection of polyester PVC fabrics.
Non-Launderable Textiles	≤0.1% total fluorine on weight of fabric
Membrane	C6 PFAS represent approximately less than 1% of total weight of the membrane

Appendix III

Assumed usage rates for PFAS in TULAC 1990 – 2050 (using low estimate value as baseline) (all values in tonnes)

PFAS substance group	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-polymer PFAS	2,740	3,031	3,353	3,840	4,511	5,151	5,662	6,214	6,826	7,501	8,247	9,070	9,979
Fluoropolymers	15,452	17,095	18,912	20,922	23,145	25,606	33,092	46,328	57,992	64,027	70,466	74,061	77,839
Side-chain fluorinated polymers	1,483	1,615	1,760	1,922	2,100	2,297	2,430	2,551	2,685	2,833	2,996	3,177	3,376
Overall total use	**19,675**	**21,740**	**24,025**	**26,683**	**29,756**	**33,053**	**41,183**	**55,093**	**67,502**	**74,362**	**81,710**	**86,308**	**91,194**

Estimated emissions for PFAS in TULAC 1990 – 2050 (using low estimate value as baseline) (all values in tonnes)

PFAS substance	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-polymer PFAS	653	704	759	839	944	1,039	1,111	1,187	1,268	1,355	1,447	1,547	1,653
Fluoropolymers	1,563	1,729	1,913	2,116	2,341	2,590	3,347	4,695	5,878	6,490	7,153	7,518	7,902
Side-chain fluorinated polymers	356	375	394	414	436	458	475	491	508	525	543	561	580
Total emission to the environment (all PFAS)	**2,573**	**2,808**	**3,066**	**3,370**	**3,721**	**4,087**	**4,934**	**6,373**	**7,654**	**8,370**	**9,144**	**9,626**	**10,135**