



Summary page:

2nd Stakeholder Consultation on a Restriction for PFAS

I. Reasons and aims of this analysis

Update: The submission period was extended from the 19th of September to the 17th of October 2021!

The competent authorities for REACH of the Netherlands, Germany, Denmark, Sweden and Norway are currently preparing a REACH Annex XV Restriction Dossier for the group of PFAS (per- and polyfluoroalkyl substances) described below (as defined under Section II. Substances) since all these substances are considered to be persistent.

The consequences of this persistence include that the presence of these substances in the environment is practically irreversible, and pose an unacceptable risk to the environment and humans. All uses of PFAS (professional and industrial uses, consumer uses of mixtures and articles) result in emissions into the environment and contribute to the overall concentrations of PFAS in the environment. Many members of this group already occur ubiquitously in the environment and contaminate the ground- and untreated water due to their high mobility. In addition, some of these substances accumulate in biota and/or are suspected to be toxic.

In view of these properties, the above mentioned competent authorities for REACH are considering proposing EU-wide measures covering all PFAS (as defined under Section II. Substances) to reduce those risks.

This questionnaire is intended to provide you/the respondents with the current overview the five authorities have on the different uses of PFAS. By checking the presented data and providing feedback you/the respondents can ensure that the correct information is used for the assessment and preparation of a REACH Annex XV Restriction Dossier. Furthermore, you/the respondents can provide the authorities with currently still lacking information. EEA tonnages & emissions presented depict the European perspective, which the authorities created from the gathered information. If tonnages or emissions are challenged, please do so at European level, not at individual company level. For alternatives (and transition costs) this is slightly different and individual companies likely have valuable information.

I. Reasons and aims of this analysis

General:

The purpose of the 'investigation report summaries' (download is possible on the next page) is to present our current knowledge and understanding regarding uses of PFAS with a focus on use tonnages, emissions, alternatives and substitution costs, etc. The data are important for both risk assessment and the socio economic analysis (SEA).

The investigation report summaries have been prepared based on more detailed PFAS use investigations. It should be noted that these investigation report summaries should not be considered to be equivalent to the Annex XV restriction report, which is in a preparation phase.

Presented data reflect the current knowledge and during the project new data might become available. It is not guaranteed that the information presented here will be used in the Annex XV restriction report or in the presented way. For instance: Presented quantities or costs could be higher or lower.

The information provided is largely of a general nature and is not intended to address the specific circumstances of any particular individual or entity. Further, the information is not professional or legal advice. In case respondents fill out the survey several times, only the latest entry will be considered.

Scope:

This survey is intended to provide an opportunity for stakeholders to confirm the understanding of the five countries preparing the restriction proposal, or provide updated information, on PFAS uses, including tonnages, emissions, alternatives and transition costs. Information can also be valuable, if it confirms estimates that are currently marked as uncertain by the five countries.

This survey is not intended as an opportunity to provide feedback on the essential use concept.

This survey is not intended as an opportunity to provide feedback on the (chemical) scope of the proposed restriction.

The use of PFAS in fire fighting foams is not part of this call for evidence. ECHA is preparing a separate Annex XV restriction dossier on this use.

Stakeholders are invited to add information on uses not mentioned in the report summaries under section A (general questions).

Public sources / literature references:

Presented numbers (i.a. tonnages & emissions) represent the situation in the European Economic Area (EEA). If you have a different view, please provide this information on EEA level with reference to public sources.

In case transition times are applicable due to substitution, please refer to the respective legal text where possible. In instances where the information presented in the investigation report summaries is challenged, but no reference to literature or public sources are made to justify such challenges, we are unlikely to be able to take the comments into account.

Others:

PFAS tonnages for the described uses cannot be added up for a full tonnage overview as this might lead to double counting. In case no information is available, the authorities will follow a reasonable worst-case approach when estimating emissions to the environment. Concerning the presented summaries, the authorities from the five countries do not accept any liability with regard to the use that may be made of the information contained. Use of the information in these summaries remains the sole responsibility of the reader. Although, the information provided in the summaries has been prepared with the utmost care, possible errors or omissions cannot be excluded. The authorities from the five countries do not accept any liability with regards to any such errors or omissions.

II. PFAS in scope

As indicated by the name, per- and polyfluoroalkyl substances (PFASs) comprise a group of organic substances containing alkyl groups on which all or many of the hydrogen atoms have been replaced with

fluorine as structural fragments.

PFAS in the scope of this call for evidence have the following structural formula:

$X-(CF_2)_n-X'$ with $n \geq 1$ and X, X' not being H (thus including $X-CF_3$) meaning fluorinated substances that contain at least one aliphatic carbon atom that is both, saturated and fully fluorinated, i.e. any chemical with at least one perfluorinated methyl group ($-CF_3$) or at least one perfluorinated methylene group ($-CF_2-$), including branched fluoroalkyl groups and substances containing ether linkages, fluoropolymers and side chain fluorinated polymers.

Although all PFAS will be considered for regulation, a non-exhaustive list of the most frequently used substances and substance groups may be found in the supplementary document accompanying this questionnaire and consultation which can be downloaded under the following link: [Supplementary document.pdf](#)

III. Target group of this questionnaire

Questions are addressed to the whole supply chain including **industry associations, manufacturers, importers, distributors and downstream users.**

Of interest is information on **PFAS** and **alternatives to PFAS**. Both, PFAS as such and PFAS contained in mixtures and articles are of relevance. Alternatives include chemical (non-fluorinated) as well as technical replacements for PFAS.

Please note that this questionnaire consists of 66 pages in total. It will, however, allow you to navigate through blocks of questions depending on your type of information or data. Hence, you will be able to specifically respond to the questions relevant to you. There will be max. 4 pages of questions per use ticked in Section A (general questions).

In the table below, the hyperlinks on the right side will allow you to download summary reports for the different uses for which further information is requested. In some cases a second hyperlink is available. In these cases the lead authority assessing the use already published a summary report on their website.

Use	Hyperlinks to report summaries
Cleaning agents, polishes and waxes (non-industrial uses)	Report summary cleaning agents polishes waxes july 2021.pdf
Cosmetics	Report summary cosmetics july 2021.pdf
Food contact materials & packaging	Report summary food contact materials and packaging july 2021.pdf
Lubricants	Report summary lubricants july 2021.pdf
Construction products	Report summary construction july 2021.pdf
Medical devices	Report summary medical devices july 2021.pdf
Medicinal products	Report summary medicinal products july 2021.pdf
Metal plating & manufacturing of metal products	Report summary metal plating and manufacturing of metal products july 2021.pdf
PFAS production (manufacturing)	Report summary PFAS and PFAS polymer production july 2021.pdf

Ski treatment	Report summary ski treatment july 2021.pdf PFAS in the treatment of skis - use, emissions and alternatives
TULAC (textiles, upholstery, leather, apparel and carpets)	Report summary TULAC july 2021.pdf
Petroleum & mining	Report summary petroleum and mining july 2021.pdf PFAS in mining and petroleum industry – use, emissions and alternatives
F-gas uses	Report summary F gas uses july 2021.pdf Application of Fluorinated Gases (F-Gases) in the European Economic Area
Electronics & energy	Report summary electronics and energy july 2021.pdf
Transportation	Report summary transportation july 2021.pdf
Waste	Report summary waste july 2021.pdf

IV. Information on institute/organisation/person & data protection rights

Information on institute/organisation/person & data protection rights can be downloaded via the following link: [GDPR.pdf](#)

Fields marked with * on this page are mandatory fields.

PERMISSION FOR INFORMATION PURPOSES: I agree to the personal data I provide in the present survey, including my name and my e-mail address, to be collected, processed and stored for potential follow-up questions regarding this survey by the service provider of the Federal Institute for Occupational Safety and Health (BAuA), namely Webropol Deutschland GmbH, and to these being subsequently stored in the database of the Federal Office for Chemicals.

*

Yes

Information on institute/organisation/person

Name	5.1.2e
Surname	
Name of institute/organisation	The Chemours Company FC, LLC – Thermal and Specialized Solutions segment. This submission, and information provided, focuses on F-gases and this portion of Chemours' portfolio within the scope. In addition, a separate submission from the Chemours Advanced Performance Materials segment will be provided.
E-Mail	5.1.2e @chemours.com

Can we contact you with follow-up questions? *

Yes

Note on Confidentiality of information and data

I understand that it is my responsibility not to include confidential information in responses to general comments and in any responses to requests for specific information (e.g. company name, properties, assets, costs etc.). The competent authorities for REACH will not be held liable for any damages caused.

*

Yes

I understand that it is my responsibility to mark confidential data and attachments as confidential. *

Yes

V. Questions - Section A - General questions

For which use would you like to submit information? Please select all uses on which you would like to provide information.

Lubricants
Construction products
Medical devices
PFAS production (manufacturing)
F-gases
Electronics & energy
Transportation
Waste

If relevant, please further specify your use (e.g. textiles used in personal protective equipment).

Substances used as refrigerants, foam blowing agents, propellants, fire extinguishants, immersion cooling fluids, solvents and working fluids for organic rankine cycle processes & high temp heat pumps

Are certain uses of PFAS missing in the categories above?

As a manufacturer and importer of F-gases, the segments referenced above are all-inclusive.

V. Questions - Section B - Cleaning agents, polishes & waxes

(non-industrial uses)

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary cleaning agents polishes waxes july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Cleaners (for glass, metal, ceramic, carpet and upholstery)	?	?	?
Aftermarket carpet care	?	?	?
Dishwashing products (rinse aids)	?	?	?
Dry cleaning products	?	?	?
Waxes and polishes (for i.e. furniture, floors and cars)	?	?	?
Windshield wiper fluids	?	?	?
Windshield treatments (for automobiles)	?	?	?
Rain-repellent fluids	?	?	?

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the

waste stage of the articles. These emissions are covered in a separate section.

V. Questions - Section C - Cleaning agents, polishes & waxes

(non-industrial uses)

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Cleaners (for glass, metal, ceramic, carpet and upholstery)	- hydrocarbon or silicone based surfactants - siloxane gemini surfactants
Aftermarket carpet care	- silicone dioxide
Dishwashing products (rinse aids)	?

Dry cleaning products	?
Waxes and polishes (for i.e. furniture, floors and cars)	- carnauba wax - nonfluorinated non-ionic or anionic surfactants
Windshield wiper fluids	- non fluorinated surfactants (e.g. sodium dioctyl sulfosuccinate)
Windshield treatments (for automobiles)	- polydimethylsiloxane
Rain-repellent fluids	?

V. Questions - Section D - Cleaning agents, polishes & waxes

(non-industrial uses)

Questions in relation to impact of legislative measures

(for companies and industry associations)

V. Questions - Section B - Cosmetics

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary cosmetics july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes F) per year in the EEA ¹	Expected trend (--/-/0/+/++) ²	TF Emission ³ /year EEA (tonnes F)	EOF Emissions ⁴ /year in EEA ⁵ (tonnes F)
Skin Care	8.2	0	6.2	0.009
Toiletries	0.6	0	0.5	0.3
Hair Care	1	0	0.9	0.5
Perfumes and Fragrances	0	0	0	0
Decorative Cosmetics	1.2	0	0.7	0.2

¹ Based on the total fluorine (TF) measurements. Quantities PFAS/year are obtained by using a conversion factor of 1.4-2.0.

² -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

³ Emissions to wastewater based on the total fluorine (TF) measurements.

⁴ Emissions to wastewater based on total extractable organic fluorine (EOF) measurements.

⁵ Emissions relate to mixture/article use. They do not include PFAS production and the waste stage of the articles. These emissions are covered in a separate section. Also note that emissions do not include mixture/article production..

V. Questions - Section C - Cosmetics

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives ¹
Skin care	?
Toiletries	?
Hair Care	?
Perfumes and fragrances	?
Decorative cosmetics	?

¹ Based on the information gathered so far, the authorities conclude that PFAS can be replaced by other ingredients and do

not have unique functions. One reason is that there are far more non-PFAS cosmetic products within the same product

categories as the PFAS containing products.

V. Questions - Section D - Cosmetics

Questions in relation to impact of legislative measures

(for companies and industry associations)

V. Questions - Section E - Cosmetics

Specific questions for the use

V. Questions - Section B - Food contact materials & packaging

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary food contact materials and packaging july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA PFAS solely polymers in table	Expected trend (--/-/0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Packaging	Product: 41,351,000 (paper and board) Product: 20,500,000 (plastic packaging) PFAS: 827 - 4,962 (in paper and board) PFAS: ? (for plastic packaging)	+ (3%)	124 - 871

Cookware	Product: ? PFAS: 3,500 (Plastic Europe, AFW, 2017)	+ (5%)	1,633 - 4,716 (mainly recoating emissions)
Industrial applications	Product: ? PFAS: 3,000 ³ (Plastic Europe, AFW, 2017)	++ (10 - 20%)	

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste stage of the articles. These emissions are covered in a separate section.

³ Including pharmaceuticals (could not be disaggregated).

V. Questions - Section C - Food contact material & packaging

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Packaging	- natural greaseproof paper - vegetable parchment - clay coatings - silicone - biopolymers (e.g. chitosan, starch, cellulose, polyvinyl alcohol, bioplastics such as polylactic acid (PLA), biowaxes) - synthesis plastics (e.g. low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), high density polyethylene (HDPE), polypropylene (PE), ethylene vinyl alcohol (EVOH), polyvinyl alcohol (PVOH), polyvinylidene chloride (PVDC), polyethylene terephthalate (PET)) - microfibrillar cellulose (MFC), cellulose nanofibrils (CNFs), cellulose nanocrystals (CNCs) - aqueous dispersions of co-polymers (e.g. styrene acrylic emulsion (SAE)) - aqueous dispersions of waxes (e.g. TopScreen) - water soluble hydroxyethylcellulose (HEC) - alkyl succinic anhydride (ASA), alkyl ketene dimer (AKD) - aluminium foil - lamination using impermeable barriers - other plant fibres (miscanthus, etc.) - bitumen coating - re-usable materials

Consumer cookware	- 'ceramic' coatings (sol-gel) as replacement of coating material - silicone coatings as replacement of coating material - silicone cookware (not coated metal) as alternative base material, uncoated - superhydrophobic coatings and hydrophobic coatings as replacement of coating material (Nanoscopic layer which is able to resist water. They are made from different materials like zinc oxide polystyrene, precipitated calcium carbonate, carbon nano-tube substances, manganese oxide polystyrene.) - enamelled cast iron / seasoned cast iron as alternative base material and non-stick coating - full ceramic cookware (not just coated) as alternative base material - carbon steel as alternative base material, uncoated - anodized aluminium coating as alternative base material, may be coated - stainless steel as alternative base material, uncoated - copper as alternative base material, uncoated
Industrial applications	- stainless steel - ceramic coatings - silicone and silicone coatings - synthetic rubbers and similar compounds (nitrile rubber, ethylene propylene rubber, neoprene, PES (polyethersulfone))

V. Questions - Section D - Food contact material & packaging

Questions in relation to impact of legislative measures

(for companies and industry associations)

V. Questions - Section B - Lubricants

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary lubricants july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Formulation of lubricants	< 3,000	+ (5% up to 2030)	in soil, surface water and air: 50 in waste stage: 40
In-use stage (sealed articles)	< 3,000	+	80
In-use stage (open applications)	100	+	90

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and only for

the formulation of lubricants also the waste stage of the articles. The emissions for PFAS production and

the waste stage
are also covered in a separate section.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

No

Do you have information that indicates that the information provided on the emissions should be adjusted?

No

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

no information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

No

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

Most fluorinated solvents are used in airless / vacuum vapor degreasing systems. For other carrier fluid applications such as lubricant deposition, and watchmaking, the vapor of the carrier fluid is captured by condensing coils and returned to the coating tank <https://bit.ly/TSSRef0>

V. Questions - Section C - Lubricants

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
PTFE (micropowder)	- graphite - amorphous silica - molybdenum disulphide - boron nitride, other inorganics (e.g. layer building zinc phosphates) - water-based phenolic-melamine gold lacquer' alternative (still in R&D phase)
PTFE-thickened silicone oil for specific applications	- polyurea
High-bearing aromatic thermosetting polyester (ATSP) coating	- graphene

What is the specific application/functionality of PFAS in your product(s)/processes?

1. PFAS are used in carrier fluids for lubricants, adhesives, coatings, and other additives.
2. Critical cleaning solvents (vapor degreasing) are used for aerospace, aircraft, military, medical, electronic parts, and other components.
3. Solvents are used for cleaning parts that are used in an oxygen-enriched environment.
4. Parts and components used in these industries must be absolutely reliable throughout their designed lifetime and must meet the strictest cleaning and safety standards. If parts are not properly cleaned, they can affect the subsequent downstream fabricating processes and failure can be catastrophic, with possible loss of lives.

Are in your view the listed non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

TCE, nPB, PERC, DCM are the closest alternatives but are extremely toxic and are being phased out. For instance, nPB has an ODP value of 0.018. The surface tension of aqueous cleaning agents is too high which prohibits effectiveness in cleaning small and complex parts. Aqueous cleaning agents are also corrosive to metals, have high energy costs, and require extensive wastewater treatment, and, there are irregular water disposal practices across end-users.

Organic solvents (HC, alcohols, esters, and ketones) are flammable. Some are VOC air pollutants with limited solvency (low Kb values) and thus, are not suitable for oxygen service cleaning applications. Also, Volatile Methyl Siloxanes, are persistent & bioaccumulative.

tDCE alone is flammable and requires at least 5% concentration blend of the PFAS solvent. S-critical CO2 requires a pressure vessel that limits the size of the part and has safety and contamination concerns.

Eurostat: <https://bit.ly/TSSRef1>

Impel: <https://bit.ly/TSSRef2>

Are in your view the listed non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

Non-PFAS alternatives cannot replace the fluorinated solvents in critical cleaning applications, as it is the case for carrier fluids in lubricant applications. They do not possess the required solvency for critical cleaning. It will force users to switch to unreliable and unproven cleaning agents and processes, which can lead to failure that can be catastrophic and have long-lasting economic impact on the value chain. For use of low-flashpoint flammable solvents, explosive-proof equipment will be required which significantly increases the capital, operation and energy costs, reduces throughput, and produces poorer results. Such operations can force small and mid-size operators out of business as the cost of production parts will be much higher than foreign competitors. Finally, due to the unique properties of PFAS solvents, a universal replacement is not available.

Do you have information on the alternatives' risk profile?

Yes

Please describe.

nPB, TCE, PER, DCM toxicity profiles are available on several industry authorities' websites worldwide, including ECB, EPA, WHO, and CDC, as well as industrial organizations such as ACGIH (American Conference of Governmental Industrial Hygienists). Risk profiles of flammable solvents are readily available through various government, industrial organizations, and chemistry textbooks, examples of which can be found at the following links.

<https://bit.ly/TSSRef3> (nPB)

<https://bit.ly/TSSRef4>

<https://bit.ly/TSSRef5> (TCE)

<https://bit.ly/TSSRef6> (TCE)

<https://bit.ly/TSSRef7> (PERC)

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

Legal and regulatory approval processes can be found at the following links:

<https://bit.ly/TSSRef3>

<https://bit.ly/TSSRef27>

<https://bit.ly/TSSRef28>

<https://bit.ly/TSSRef4>

<https://bit.ly/TSSRef29>

What is the average approval time?

Seeking approval of these toxic substances in vapor degreasing will depend on EU regulatory authorities, however, an estimated 1 to 5 years should be expected. The use of flammable cleaning agents will require the approval of competent authorities in each of the EU Member States, which may take up to 3 years. Aqueous cleaners generate a large amount of wastewater stream which requires extensive treatment before discharge. Permits from local authorities will be required with approval times taking up to 2 years.

<https://bit.ly/TSSRef30>

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable not only our own operations but those of our customers and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint.

With this objective, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

Based on previous experience, the process of invention, manufacturing and commercialization may take between 10-15 years combined with a substantial financial investment.

Do you have information on additional alternatives for any of the described applications that have not been disclosed in the attached information?

No

V. Questions - Section D - Lubricants

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Limited impact. The Current F-gas regulation requirements already in place address issues such as leak detection/repair, recovery, reclaim and recycle throughout the systems' operating lifetime, including end-of life, ensuring minimal impact to the environment. Industry associations have recommended extending the F-Gas provisions on containment and recovery to all types of refrigerants, including HFOs and non-fluorinated alternatives. This would have numerous benefits in terms of environmental protection, safety and energy efficiency.

V. Questions - Section B - Construction products

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary construction products july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use		Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Polymeric PFAS	Formulation of articles and commercial construction mixtures	7,390	++ (5 - 8% for PTFE, PVDF, EFTE until 2030)	in soil, surface water and air: 330 in waste stage: 170
	In-use stage (outdoor articles)	3,270		in soil, surface water and air: 212
	In-use stage (indoor applications)	3,270		in soil, surface water and air: 2
	In-use stage (outdoor mixtures)	164		in soil, surface water and air: 9
	In-use stage (indoor mixtures)	150		in soil, surface water and air: 0.1

Non-polymeric PFAS	Formulation of articles and commercial construction mixtures	10,900	+ (1% for 2020 -2050)	in soil, surface water and air: 273 in waste stage: 163
	Use of processing aids	3,700		in soil, surface water and air: 5 in waste stage: 3,695
	In-use stage (outdoor articles)	1,712		in soil, surface water and air: 110
	In-use stage (indoor applications)	1,712		in soil, surface water and air: 1
	In-use stage (outdoor mixtures)	1,420		in soil, surface water and air: 91
	In-use stage (indoor mixtures)	1,502		in soil, surface water and air: 0.75

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and only in

some cases the waste stage of the articles. The emissions for PFAS production and the waste stage are also covered in a separate section.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

No

Do you have information that indicates that the information provided on the emissions should be adjusted?

No

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

no information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

No

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

Chemours provides users of their foam blowing agents with product use, storage and handling information (to be found here: <https://bit.ly/TSSRef8>) which includes information on safe use, storage and handling. Foam blowing agents sold by Chemours pose no acute or chronic hazard when handled in accordance with Chemours recommendations and when the exposure is maintained below the WEEL of 500ppm (8-hr TWA).

V. Questions - Section C - Construction products
Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Thermal insulation applications	- polyisocyanurate - phenolic thermal product
Processing aids in the production of construction products	? (only confidential information)

Architectural fabrics	- cotton and other natural fibres - polyamid (nylon) - polyester - fiberglass - aramid (Kevlar, Twaron) - carbon fibres
Fluoropolymer tube lining	- polypropylene - silicone - PVC
Paints and coatings	- polyurethane - polyester powder - wax emulsions - silicones/silanes/polysiloxanes - hydrocarbon polymer technologies
Coating additives	- hydrocarbon and silicone-based surfactants - short chain, polyether-modified siloxanes - low molecular weight polyether-modified siloxanes - siloxane multi-functional surfactants - alkoxylates (silicone and solvent-free)
Superhydrophobic coatings	- polymeric matrix (the binder) added to hydrophobic nanoparticles (the filler)
Wood primer and inks	- sulfosuccinates (e.g. sodium salt of di-(2-ethylhexyl) sulfosuccinate)
Rust protection systems, marine paints, resins, printing inks and coatings in electrical applications	- propylated naphthalenes - propylated biphenyls

What is the specific application/functionality of PFAS in your product(s)/processes?

In construction, fluorinated gases HFO-1336mzz-Z, HFO-1336mzz-E are used as blowing agents in the production of certain closed and open cell polyurethane/polyisocyanurate/XPS foams like in-situ spray foam, appliance insulation, and integral skin. Polyurethane foam (PUR/PIR) is produced through a chemical reaction between a polyol & isocyanate component. HFO/HCFO in this application have boiling point near room temperature (0-40 C). The polyurethane reaction releases heat which causes the blowing agent to evaporate and be captured in the foam matrix. The HFO/HCFO reduces the foam density, increases the polymer thermal resistance, while increasing strength & dimensional stability of the polymer. HFO/HCFOs in this application are non-flammable, making them the sole substances that can replace HFCs (currently being phased down via the F Gas regulation) in many applications such as spray foam, and many continuous and discontinuous architectural panel & insulation panel manufacturing plants.

Are in your view the listed non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

Section 4.2.2 of the Exponent International Report "Application of Fluorinated Gases (F-Gases) in the European Economic Area" clearly indicates that there are no alternatives for several thermal insulation applications. Therefore, the mention of Polyisocyanurate and phenolic thermal products as alternatives does not apply to in-situ spray foam and discontinuous production plants. To date, alternatives to HFO/HCFO do entail significant drawbacks in terms of flammability, ability of insulation to resist fire, insulation performance, poor dimensional stability at low density, thickness penalty and durability.

Are in your view the listed non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

Alternatives to HFO/HCFO blown polyurethane/polyisocyanurates foam insulation would require a change of building design, also major changes to energy and safety codes resulting in less effective insulation. Spray polyurethane foams containing HFOs provide the added benefit of improved air tightness of the structure, improving the overall energy efficiency of a buildings HVACR system. For renovation works or upgrading of buildings, decision-makers are not likely to find alternatives and thus, future buildings will be less energy efficient. For OEM panel manufacturers, conversion to pentane is very expensive, estimated capital investment of minimum \$500,000 per installation. For appliances, the A and B energy efficiency standards will be difficult to meet with PUR blown with pentane/HFO blends. Methyl Formate and/or water blown foams perform poorly in comparison to HFOs in the European Standard that specifies requirements for in-situ formed sprayed rigid (PUR/PIR) products EN 14315:2013.

Do you have information on the alternatives' risk profile?

Yes

Please describe.

All alternatives are man-made products and are comprised of substances exhibiting hazards from the Classification, Labelling and Packaging (CLP) regulation (from fiber to biocides). Methylal is flammable, even when blended with HFO/HCFOs. Methyl formate converts to formic acid in the presence of water, leading to equipment corrosion issues and health safety concerns. Pentane gases are explosive, and foams made from them are highly flammable. All alternatives have reduced thermal efficiency in insulation and will result in millions of tons of CO2 emissions that could have been mitigated with the use of polyurethane foam made with HFO blowing agents.

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

The legal framework is the Construction Products Regulation (CPR) which is addressed by harmonized technical Specifications. Those specifications cannot be amended in a quick and flexible manner, hence the successors to the substances listed under Annex I of the F Gas Regulation have not yet been incorporated into the CPR due to EU administrative hurdles (all the technical evidence has been provided but the validation process is blocked by the review of the CPR).

What is the average approval time?

Based on previous experience 2-4 years may be likely required.

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With this objective, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

Based on previous experience, the process of invention, testing, manufacturing and commercialization may take between 10-15 years combined with a substantial financial investment.

Do you have information on additional alternatives for any of the described applications that have not been disclosed in the attached information?

No

V. Questions - Section D - Construction products

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Polyurethane Foam Insulation Products have a long useful lifetime (50 years or more for Spray Foam, 15-20 years for appliances). PFAS collection and treatment pathways continue to be investigated. Several new companies are currently recycling foam and these processes could be adapted to collect or treat PFAS.

V. Questions - Section B - Medical devices
Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary medical devices july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use ¹	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+ /++) ²	Emissions/year in EEA ³ (tonnes/PFAS)
Anesthetics	2 - 1,000	+	~ 2 - 1,000
Contrast media	2 - 100	?	~ 2 - 100
Propellants	160 - 400	?	~ 160 - 400
MDI incl. F-gases	24,000 - 43,000	?	~ 4,200
Medical devices incl. packaging (mainly polymers)	3,700 - 14,000	?	90

¹ Contrast media, propellants and F-gases are mentioned here as medical devices.

² -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

³ Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste stage of the articles. These emissions are covered in a separate section.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

The "tonnage per year in the EEA" for MDIs appears to be the total EEA tonnage of HFC 134a & HFC 227ea and not the quantity actually used in MDIs. A more representative tonnage can be estimated using the annual tonnes of CO₂e reported under the MDI exemption (from the report Fluorinated greenhouse gases 2020 (Table A5.25)) and dividing it by an assumed GWP of 1600 (92% HFC 134a & 8% HFC 227ea (MCTOC 2018)) giving an annual usage of 6000 – 7000 tonnes then adding to that a fraction of the "Other [pre-filled] products and equipment" given in table A5.11 to allow for imports of pre-filled MDIs. An estimated one third to one half of the annual quantity of MDIs manufactured is exported to patients outside of the EEA.

Do you have information that indicates that the information provided on the emissions should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

The source of the emissions number is unspecified, but it appears consistent with around one third to one half of all MDIs produced in EEA exported to patients outside the EEA.

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

The ERC of 100 % assumed in this process is a conservative estimate based on the reasonable premise that the function of MDIs requires the propellant to be released and the propellant is unaltered in the process of delivering the treatment. Presumably for the sake of ease, it assumes that although many MDIs are either not used or not completely used before they are disposed of, all the propellant in all MDIs is ultimately released to the environment. It is noted that although there are MDI return systems in place, their effectiveness at reducing propellant emissions is considered to be negligible in the assumed ERC.

Do you have information that indicates that the information provided on the expected trend should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

There are opposing factors to consider when estimating future trends of MDI propellant consumption and use in the EEA, including:

- 1) The EEA is a major global producer of MDIs and global MDI use is growing (MCTOC 2018 & EEA Fluorinated gas reports) indicating an increasing trend
- 2) However, a reducing trend is likely based on the following factors
 - a. Using new alternative propellants with lower liquid density and lower GWP
 - b. Moving to alternative NIK delivery systems for some treatments
 - c. The impact of the EU F-gas Regulation on EU MDI manufacturing
 - d. The impact of national health policies.

Overall, a flat or slight downward trend in tonnes of propellant used in MDIs in the EEA can be expected over the next 10 years.

That said, a significant new MDI treatment or a significant move away from an existing major MDI treatment (e.g. Salbutamol) or the move out of the EEA of MDI production for production in the rest of world all have the potential to have a large effect on the trend.

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

A number of health studies are available, of which we have referenced one below:
Human safety and pharmacokinetics of the CFC alternative propellants HFC 134a (1,1,1,2-tetrafluoroethane) and HFC 227 (1,1,1,2,3,3,3-heptafluoropropane) following whole-body exposure
H H Emmen 1, E M Hoogendijk, W A Klöpping-Ketelaars, H Muijser, E Duistermaat, J C Ravensberg, D J Alexander, D Borkhataria, G M Rusch, B Schmit
<https://bit.ly/TSSRef9>

V. Questions - Section C - Medical devices

Questions in relation to alternatives (mainly for individual companies)

What is the specific application/functionality of PFAS in your product(s)/processes?

Chemours manufactures HFC propellants for use in MDIs.

Are in your view non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

Whilst it is true that alternative NIK treatment solutions are available for some existing MDI treatments, it is not true to say that there is currently a technically feasible NIK alternative for all MDI treatments for all patient groups. The MCTOC 2018 assessment report states "It is not yet technically or economically feasible to avoid HFC MDIs completely in this sector because, currently; for salbutamol, there are economic impediments in switching forms from some HFC MDIs to multi-use DPIs; and some patients (young children and frail elderly) cannot use DPI alternatives to HFCs MDIs"

The same inability to use a DPI is expected to be true for most veterinary applications of MDIs.

Therefore, the feasibility of finding technically viable non-PFAS alternative propellants for all MDIs, allowing continued MDIs used for the necessary treatments and patient groups, may well rest on the final PFAS definition used in any restriction.

Are in your view non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

Whilst it appears likely that for some treatments non-PFAS NIK alternatives are economically feasible this is not the case for all MDI treatments. The MCTOC 2018 assessment report states "It is not yet technically or economically feasible to avoid HFC MDIs completely in this sector because, currently; for salbutamol, there are economic impediments in switching forms from some HFC MDIs to multi-use DPIs; and some patients (Young children and frail elderly) cannot use DPI alternatives to HFCs MDIs".

As above, the feasibility of finding economically viable non-PFAS alternative propellants for all MDIs, allowing continued MDIs used for the necessary treatments and patient groups, may well rest on the final PFAS definition used in any restriction.

Do you have information on the alternatives' risk profile?

No

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

All medicines must go through a strict regulatory approval process which can take several years to complete and this process often needs to be repeated across a number of national and regional approval agencies including EMA, MHRA, FDA, etc.

What is the average approval time?

Typical approval time for a new propellant is up to 7-10 years.

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With this objective, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

A complete transition of a new MDI propellant would take more than 10 years to develop, test, approve, install new production facilities and gain acceptance from prescribers & patients. This assumes that a suitable non-PFAS alternative propellant can be identified. It is noted that between ~1989 - 2003 a similar regulatory-enforced transition took place from CFCs to HFCs due to the Montreal protocol. Commission communication COM (1998) 603 final, written when that transition was already well underway, includes many of the considerations that will still be relevant for an MDI propellant transition under a new restriction. Albeit that some of the data on usage in this communication is out of date referring as it does to CFCs. The regulatory approvals process is also different. Some fluorocarbon alternatives are already going through this transition with some MDI producers having announced plans to begin use of alternatives to R-134a starting in 2025 with a full replacement possibly by 2030

Do you have information on alternatives for any of the described applications in the attached information?

One alternative being investigated as new MDI propellants is listed as 1,1-difluoroethane (HFC- 152a). Although butane has also been proposed as an MDI propellant, no EMA approved treatments are known to exist using butane.

V. Questions - Section D - Medical devices

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

At the propellant producer level the handling and disposal of the gases is already well managed with little impact anticipated under any new specific waste management requirements.

At the end user (general public) level it is anticipated, based on the current level of return of MDIs at the end of their useful life, that it would require a significant effort by the member states, regulators and supply chain actors to ensure the 100s of millions of MDIs prescribed annually in the EEA are disposed of by any specific waste management system.

V. Questions - Section E - Medical devices

Specific questions for the use

If available, please provide information on PFAS emissions during medical device production.

Chemours is a supplier of F-gases and not involved in Medical Device Production.

If available, please provide information on market trends for contrast media, propellants, F-gases and/or medical devices.

Propellant supply in the EEA is showing a small but steady increase in HFCs supplied under MDI exemption - see Table A5.25 of the Fluorinated greenhouse gases 2020. However, as stated above, new alternative propellants and the move to NIK alternative delivery systems is expected to move the trend downwards. Due in part to the impact of the F-Gas Regulation, a flat or slight downward trend of tonnes of propellant used in MDIs is expected over the next 10 years in the EEA.

If available, please provide information on fluorine-free alternatives for medical devices.

A number of not-in-kind delivery systems are available that do not use propellants with F-gases.

For a number of patient groups and veterinary applications, suitable fluorine free/non-HFC MDI alternatives are not known to exist at this time.

Reference documents:

The Climate is Changing for Metered-Dose Inhalers and Action is Needed

John N Pritchard, Inspiring Strategies, Leicester, Leicestershire, UK

Drug Design, Development and Therapy 2020:14 3043–3055

Omar Usmani 'Our Planet or our Patients':

<https://bit.ly/TSSRef10>

V. Questions - Section B - Medicinal Products

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary medicinal products july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (---/0/+/++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Medicines (human pharmaceuticals)	> 500 ³	+	> 500 ³
Medicines (veterinary pharmaceuticals)	?	?	?
Pharmaceutical intermediates ³	8,200 (ECHA)	?	?

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste

stage of the articles. These emissions are covered in a separate section.

³ The whole molecule/API is counted in this calculation.

V. Questions - Section C - Medicinal Products

Questions in relation to alternatives (mainly for individual companies)

V. Questions - Section D - Medicinal Products

Questions in relation to impact of legislative measures

(for companies and industry associations)

V. Questions - Section E - Medicinal Products

Specific questions for the use

V. Questions - Section B - Metal plating & manufacturing of metal products

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary metal plating and manufacturing of metal products july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Metal plating	2 - 57 (6:2 FTS in chrome plating)	-	11.4 (6:2 FTS in chrome plating)
Manufacture of metal products	960 (fluoropolymers)	0	?

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste

stage of the articles. These emissions are covered in a separate section.

V. Questions - Section C - Metal plating & manufacturing of metal products

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
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Metal plating (here specifically chrome plating)	- alkane sulfonates - amines, C12-C14 alkyl, ethoxylated - oleo amine ethoxylates (e.g. mixtures with (Z)-octadec-9-enylamine, ethoxylated) - 3-[dodecyl(dimethyl) ammonio]propan-1-sulfonate (mixture with 3-hydroxypropane-1-sulfonic acid and amines, coco alkyl dimethyl, N-oxides) - paraffin oils, sulfochlorinated, saponified - isodecanol, ethoxylated - chromium (III) plating - add-on air pollution control devices (e.g. packed bed scrubbers) - thermal spraying (e.g. high velocity oxygen fuel process) - physical vapour deposition - case hardening process (e.g. plasma nitriding) - laser metal deposition - anhydrous ionic liquids based on chromium (III) salts - closed coating reactors - nickel-based coatings - sulfonation of plastics with sulfur trioxide in the gas phase - acidic permanganate solutions, nitric acid and trichloroacetic acid mixtures
Manufacture of metal products	?

V. Questions - Section D - Metal plating & manufacturing of metal products

Questions in relation to impact of legislative measures
(for companies and industry associations)

V. Questions - Section E - Metal plating & manufacturing of metal products

Specific questions for the use

V. Questions - Section B - PFAS production (manufacturing)

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary production july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Fluoropolymers	Produced: 49,458 - 101,763 Imported: 36,148 (Eurostat) Exported: 28,718 (Eurostat)	+ (stakeholder)	in air: 10 - 20 in water: 3 - 6

F-gas	Produced: 13,600 - 52,800 Imported: 84,284 (Literature) Exported: 10,371 (Eurostat)	0 (stakeholder)	in air: 280 - 1,086 in water: 0.6 - 2.3
Remaining PFAS	Produced: 53,902 - 118,051 Imported: 103,586 (Eurostat) Exported: 131,866 (Eurostat)	+ (stakeholder)	in air: 11 - 24 in water: 3 - 7

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions only relate to PFAS production. They do not include mixture/article production, mixture/article use and the waste stage of the articles. These emissions are covered in the other sections of this survey.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

EEA Report No 15/2020, Fluorinated greenhouse gases 2020 contains data reported by companies on the production, import, export and destruction of fluorinated greenhouse gases. This report was used as a source for the import data on F-gases in the table above and can be used for exports and Production data as well. The summary report on Production states that the import and export information gathered through the Eurostat source only represents approximately ¼ of all legal F-gas imports (Table 2, p 9). Although we would agree with this statement, we believe that using the EEA data for imports and exports, as well as production, is more consistent.

Do you have information that indicates that the information provided on the emissions should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

We are unaware of the emissions in air data source but believe that if it is taken from: "EEA Technical Report on Annual EU GHG Inventory 1990–2019 Submission to the UNFCCC", the values should be reduced by $\geq 10x$. We expect negligible emissions to water. If an on-site aqueous waste stream contains an F-gas, by design it gets processed through the wastewater treatment system resulting in its removal. The environmental fate of a substance is highly dependent on its phys-chem properties and its emission scenario. Environmental fugacity models rely upon a substance's Henry's Law Constant (HLC) to describe its transport and partitioning between air & water at steady state. Substances with high HLC values will volatilize from water into air. Although some F-gases are moderately soluble in water, their high vapor pressures contribute to a high HLC which confirms that any residual F-gas in water will rapidly partition to the atmosphere leading to little or no aqueous exposure at a steady state.

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

no information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

Following the downward production trend reported in the EEA report, it can be estimated that the production trend will continue to reduce in the future.

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment?

Yes

Please specify and/or refer to literature/public sources.

The Chemours Netherlands Dordrecht site (CC-NL) is a BRZO company (NL version of EU Seveso guidelines). Permits for BRZO companies include Best Available Technologies (BAT) requirements, also for their emissions to the environment. The BRZO locations in NL are strictly monitored by the NL authorities.

The permits are available at the authorities (DCMR).

CC-NL has installed BAT. This includes a thermal converter (TC) since the mid-90's to treat unwanted fluorinated gaseous by-products now considered PFAS under the current broad definition.

The TC converts waste gases from the production facilities into a solution of HF in water. The fluorinated gaseous by-products are converted at a temperature of about 1150 °C by combustion of natural gas. The TC is converting at least 95% for the different feed streams. The remainder is safely emitted according permit requirements.

Chemours is investing in further emission reduction projects in line with the ambitious 10x2030 CRC goals announced in 2018.

V. Questions - Section C - PFAS production (manufacturing)

Questions in relation to alternatives (mainly for individual companies)

Please explain:

Not applicable for F-gases

V. Questions - Section D - PFAS production (manufacturing)

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

Concerning production specifically, the Industrial Emission Directive (IED) as well as Member State emission requirements regulate emission reporting.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Limited impact. The Current F-gas regulation requirements already in place address issues such as leak detection/repair, recovery, reclaim and recycle throughout the systems' operating lifetime, including end-of life, ensuring minimal impact to the environment. Industry associations have recommended extending the F-Gas provisions on containment and recovery to all types of refrigerants, including HFOs and non-fluorinated alternatives. This would have numerous benefits in terms of environmental protection, safety and energy efficiency.

Emissions from production of F-gases are already regulated by permits, the Industrial Emissions Directive as well as monitored through UNFCCC reporting. Additionally, the Waste Framework Directive already outlines requirements for waste handling for material such as waste products from refrigeration systems.

V. Questions - Section E - PFAS production (manufacturing)

Specific questions for the use

If available, please provide information on the production of PFAS alternatives.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With this objective, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

V. Questions - Section B - Ski treatment

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary ski treatment july 2021.pdf](#)

Additionally, the Norwegian Environment Agency also published a short version of the report. This version can be accessed via the following link: [PFAS in the treatment of skis - Use, Emissions and Alternatives](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (-/-/0/+/++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Ski wax	1.64	-	in soil: 0.452 in surface water: 0.452 in air: 0.041 in waste stage: 0.695

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production. The

emissions for PFAS production and the waste stage are also covered in a separate section.

V. Questions - Section C - Ski treatment

Questions in relation to alternatives (mainly for individual companies)

Sub-Use		Non-PFAS alternatives
Ski wax	Fluorine-free waxes	- hydrocarbon and paraffin waxes - siloxanes (but they are subject to environmental concerns) - nanoparticle-based waxes are being developed.

Alterations to the ski itself	- a modified microstructure of the ski base - improved performance of the polyethylene of the ski - heating the base to obtain a better glide - controlling the vibrations of the ski
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V. Questions - Section D - Ski treatment

Questions in relation to impact of legislative measures

(for companies and industry associations)

V. Questions - Section E - Ski treatment

Specific questions for the use

V. Questions - Section B - TULAC (textiles, upholstery, leather, apparel and carpets)

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary TULAC july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
	Low/High		Low/High
Home textiles	6,230/27,368	++	?
Consumer apparel	8,161/47,148	++	?
Professional apparel	5,220/20,044	++	?
Technical textiles	6,201/26,541	++	?
Medical applications	331/1,095	++	?
Leather	?	++	?
Other	15,041/20,496	++	?
Total	41,184/142,692	++	4,933/18,103

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste

stage of the articles. These emissions are covered in a separate section.

V. Questions - Section C - TULAC (textiles, upholstery, leather, apparel and carpets)

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
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Home textiles	Carpets and rugs	- non-ionic polymer - ester compounds - hydrocarbon compounds, - organic solvent and water
	Curtains	- no specific substances found, see general textile (FF)
	Upholstery (e.g. fabrics for soft-furnishings, including large furniture items)	- hydrotreated heavy naphtha (petroleum) - non-ionic polymer, ester compound, hydrocarbon compound, organic solvent and water
Consumer apparel	Outdoor wear	- non-ionic polymer - ester compounds - hydrocarbon compounds - organic solvent and water - mixture of linear and branched hydrocarbons
	Indoor wear	?
	Sports wear	?
	Footwear	?
Professional apparel	Professional sports wear and footwear	?
	PPE for industrial applications e.g. for chemical workers, fire-fighters, O&G workers, law enforcement and military forces	
Technical textiles	Outdoor technical textiles e.g. canvas, awnings, tarps, tents, bags, sails, rope, umbrellas	?
	Medical applications "non-woven", e.g. surgical drapes, gowns, curtains	
	High performance membranes e.g. automotive and medical	

Textile in
general
(multiple
sub-category
uses)

- paraffin
- non-ionic polymer
- ester compounds
- alcohols, C12-16, ethoxylated (>5-15 EO)
- hydrocarbon polymer dispersion
- aqueous preparation of polymer waxes
- paraffin oils and a fat modified melamine resin
- dispersion of paraffin wax and acrylic copolymer
- paraffin oils and a fat modified melamine resin and blocked polyisocyanates
- dispersion of paraffin oils and a fat modified melamine resin
- naphtha (petroleum), hydrotreated heavy, modified wax dispersion
- (bee-) wax
- carnauba wax
- acrylate copolymer
- dispersion of fat-modified chemicals and paraffin
- plant seed oil, bio based product
- acrylic polymer and paraffin dispersion
- acrylic polymer and silicone reactive dispersion
- acrylic polymer, reactive silicone and paraffin dispersion
- functionalised polymers/waxes, cationic
- emulsifier-free paraffin wax
- emulsion containing aluminum
- acrylic polymer and dispersion of fatty derivatives
- polyethylene oxide mono-C12-16-alkyl ether
- aminofunctional PDMS
- sodium methylsiliconate water
- potassium methylsiliconate
- isobutyltrimethoxy silane
- octylsilane
- hexyltriethoxysilane
- blend of n-octyltriethoxysilane and reactive silicone, octyltrimethoxysilane-based
- methoxy terminated silsesquioxanes
- emulsion of polydimethylsiloxane
- cationic polysiloxane and polyester
- polysiloxane
- mixtures of silicones and stearamidomethyl pyridine chloride, sometimes together with carbamide (urea) and melamine resins
- aminofunctional polysiloxanes
- water-based silicone emulsion
- solvent-dilutable silicone solution
- siloxane dispersion with modified polyamide,
- acrylic polymer and silicone reactive dispersion
- dodecamethyl pentasiloxane (PDMS)

		- aqueous, solvent free dendrimers - anionic dispersion of an aliphatic polyether urethane - polyurethane emulsion, water-based - anionic dispersion of a matt polyether polyurethane, water-based, solvent free - anionic dispersion of an aliphatic polycarbonate urethane - plasma based nano-coating, molecularly attached hydrophobic 'whiskers' attached to individual fibres, uses a hydrocarbon polymer
Leather	Leather in general	- hybrid (silicone/hydrocarbon) - solvent-dilutable silicone solution - water-based silicone emulsion
Other	Home fabric treatments (sprays)	- alkyl polysiloxane solution

V. Questions - Section D - TULAC (textiles, upholstery, leather, apparel and carpets)

Questions in relation to impact of legislative measures
(for companies and industry associations)

V. Questions - Section E - TULAC (textiles, upholstery, leather, apparel and carpets)

Specific questions for the use

V. Questions - Section B - Petroleum & mining

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary petroleum and mining july 2021.pdf](#)

Additionally, the Norwegian Environment Agency also published a short version of the report. This version can be accessed via the following link: [PFAS in mining and petroleum industry – use, emissions and alternatives](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Quantity of product used (t)	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (-/-/0/+ /++) ¹	Emissions/year in EEA ² (tonnes/PFAS)

Water and gas traces	1	1	0 ³	in soil: 0 - 0.005 in water: 0.020 - 0.025 in marine water: 0 - 0.110 in air: 0.025 - 0.070 in waste stage: 0.020 - 0.145
Drilling/Production chemicals	170	3 - 8	0 ³	in soil: 0 - 0.045 in water: 0.070 - 0.210 in marine water: 0.020 - 0.760 in air: 0.085 - 0.635 in waste stage: 0.015 - 0.230
Fluoropolymers (all) Low scenario ⁴	3,500 - 7,500.5	0.004 - 0.008 monomeric PFAS	0 ³	in soil: < 0.001 in water: < 0.001 in marine water: < 0.001 in air: 0.001 - 0.002 in waste stage: 0.001 - 0.003
Fluoropolymers (all) High scenario ⁵	3,500 - 7,500.5	0,9 - 1,9 monomeric PFAS	0 ³	in soil: 0 .020 - 0.045 in water: 0.003 - 0.006 in marine water: 0.020 - 0.040 in air: 0.270 - 0.580 in waste stage: 0.310 - 0.670

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production.

³ Conservative annual growth of 1%.

⁴ 1 ppm monomeric PFAS in fluoropolymers (Lohmann et al., 2020).

⁵ 0-2000 ppm monomeric PFAS in fluoropolymers (Ökopol 2014 and used in PFOA restriction).

V. Questions - Section C - Petroleum & mining

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Water and gas tracers	- radioactive tracers - noble gas isotopic tracer - xenon - radiolabelled compounds

Drilling and production (antifoaming)	- polydimethylsiloxane (PMDS) oils - ethyl siloxanes - polypropylene glycol - naphthalene/1,2,4-trimethylbenzene based products - dipropylene glycol monomethyl ether - 2,6-dimethylheptan-4-one.
Fluoropolymers	- steel - other metal alloys - non-metal materials (ceramic or epoxy based) - cross-linked polyethylene (XL PE) - polyamides such as ethylene propylene diene (EPDM) - hydrogenated nitrile Rubber (HNBR) - polyether ether ketone (PEEK)

V. Questions - Section D - Petroleum & mining

Questions in relation to impact of legislative measures (for companies and industry associations)

V. Questions - Section E - Petroleum & mining

Specific questions for the use

V. Questions - Section B - F-gas uses

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary F gas uses july 2021.pdf](#)

Additionally, the Norwegian Environment Agency also published a short version of the report. This version can be accessed via the following link: [Application of Fluorinated Gases \(F-Gases\) in the European Economic Area](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+/>++) ¹	Emissions/year in EEA ² (tonnes/PFAS) ³ all emissions to air for F-gases
Domestic refrigeration	122	0	17
Commercial refrigeration	7,915	+	9,547
Industrial refrigeration	2,360	-	3,680
Transport refrigeration	1,010	0	1,341
Mobile air conditioning	5,221	++	11,726
Stationary air conditioning and heat pumps	7,465	++	7,458
Foam blowing agent (closed cell)	4,940	+	4,186
Foam blowing agent (open cell)	271	0	1,074
Fire protection	863	0	703
Propellants (non-MDI)	504	-	701

Solvents	?	0	> 11
Cover gas for magnesium casting	?	+	> 23
Other	?	?	35

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste

stage of the articles. These emissions are covered in a separate section.

³ Due to large tonnages in stock, emissions can be higher than annual tonnage.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

Comments relative to F-gases in foam blowing, mobile AC & transport refrigeration, solvents have been added to Construction products, Transportation, Lubricants and Electronics & energy sections.

F-gases are essentially not used in domestic production of refrigeration equipment in line with the F-Gas Regulation prohibiting placing on the market domestic refrigerators/freezers containing HFCs with GWP of >150 as of 1 January 2015. Therefore, the referenced 122 MT does not align with market data possibly due to incorrect/inconsistent reporting at the Member State level.

Fire Protection: Most of the 863mt used for Fire applications in the EEA are exported in systems out of the EEA, not contributing to the inventory of HFCs in the EEA. As described in the EEA report, the supply of F-gases for fire protection was 130 tons in 2019.

Figures referenced in open and closed cell foam blowing agents are inconsistent with figures referenced elsewhere (construction section, for example).

Do you have information that indicates that the information provided on the emissions should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

HVACR: From the emissions data analysis it's unclear whether reclaim, recycle, recovery, or destruction is included for stationary AC/HP or commercial/industrial refrigeration. Chapter II of EU F-Gas Regulations addresses the requirements for leak detection, record keeping and recovery that when followed can achieve lower leak rates. A study published in the 2021 May-June and July-August editions of the VDKF association newspaper (<https://bit.ly/TSSRef11>) on actual commercial refrigeration systems following best practices reported achieving annual leak rate of 3.4%.

Fire Protection: The Emission value 3.48% of installed systems is high. The UNEP Halons 2018 report (<https://bit.ly/TSSRef12>) on p88 estimates the 2018 global emissions rate to be 2.5%. Given the regulated, advanced service practices of the systems in the EU, it's expected that emission rates in the EU are significantly much lower than the global estimate. The MAC data is inconsistent with the MAC use data in transport.

Do you have information that indicates that the information provided on the expected trend should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

HVACR: The expected trend of “++” in stationary AC & heat pumps and “+” in commercial refrigeration is inconsistent with the trends in these industries. In commercial refrigeration, equipment design trend is to move away from large centralized machine rooms with large charge sizes & higher leak rates, to distributed designs with smaller charge sizes, less piping & lower leak rates. Also, the application of A2L (mildly flammable) refrigerants equipment standards requiring leak detection and repair in all stationary applications, as well as limited charge sizes per circuit will inherently reduce the demand and emissions of refrigerant, despite any growth in equipment demand in these sub-uses. Also, these trends do not consider the increasing role of reclaim & destruction of refrigerants, which promotes a circular economy and further reduces emissions. This increasing trend from 2014 to present compared to prior years can be found in the EPEE presentation on p46-48. <https://bit.ly/TSSRef13>

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

HVACR: During installation, servicing, and end-of life decommissioning, applying well-established industry best practices for leak prevention, recovery, recycling, and reclaim minimizes both potential worker exposure as well as emissions. In addition to reduced charge sizes, leak detectors, either embedded in the system or located in the area, provide early warning for operators to take corrective action. Some of these well documented best practices can be found on pages 16-18 of the following report.

<https://bit.ly/TSSRef14>

Fire Protection: The systems are built and designed to only emit in the case of a fire, minimizing human exposure to only in the event of a fire. F-gas Fire Extinguishants are safe to use in occupied space, which is not the case for certain of the alternatives such as CO₂, dry chemical, and powdered aerosols.

MAC: The transition to electric vehicles requiring electric compressors will reduce leakage rates (see transportation section).

V. Questions - Section C - F-gas uses

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Domestic refrigeration	- iso-butane - propane (not in-kind refrigeration cycles)
Commercial refrigeration	- CO ₂ - isobutane - propane
Industrial refrigeration	- CO ₂ - ammonia - n-butane
Transport refrigeration	- CO ₂ - ammonia - CO ₂ with N ₂ as direct coolant - propane (not in-kind: advanced cool box storage)
Mobile air conditioning	- CO ₂ - propane
Stationary air conditioning and heat pumps	- CO ₂ - ammonia - propane
Foam blowing agent (closed cell)	Depending on the specific application: - cyclopentane - iso-pentane - n-pentane - isobutane - n-butane - 2-chloropropane

Foam blowing agent (open cell)	- dimethyl ether (DME) - methyl formate - methylal - CO₂ / methyl formate - CO₂ (water) - CO₂ (liquid) - CO₂ / ethanol - water blown foams
Fire protection	- inert gases (nitrogen and argon) - CO₂ - water mist technologies - inert gas generators - fine solid particle technology - dry chemical agents - water and aqueous salt solutions
Propellants (non-MDI)	Compressed gases: - air - nitrogen - nitrous oxide - CO₂
	Liquefied gases: - butane - propane - isobutane - dimethyl ether
	Not-in-kind alternatives: - trigger sprays - finger pumps - squeeze bottles - non-sprayed products including roll-ons - bag-on-valve products
Solvents	Depending on the specific application: - isopropyl alcohol (IPA) - n-Propyl bromide - dichloromethane - trans-1,2-dichloroethylene - trichloroethylene (TCE) - perchloroethylene (PER) - volatile methyl siloxanes - hydrocarbons (hexane, heptane, benzene) - acetone - semi-aqueous / aqueous cleaning - manual cleaning methods (aerosols, brush, trigger spray, liquid immersion, spot cleaning, wipes) - ultrasonic - plasma cleaning - supercritical fluids – CO₂ - no clean fluxes

Cover gas for magnesium casting

- SO₂
- argon
- salt fluxes
- powdered sulfur

What is the specific application/functionality of PFAS in your product(s)/processes?

HVACR: F-gases (HFOs, HFCs and blends thereof) are the working fluids (refrigerants) that enable effective absorption and rejection of heat in closed vapor compression heating and cooling systems. HVACR systems vary in size from small units using < 1 kg of refrigerant up to large building chillers with > 1000 kg and are designed to operate over a range of temperatures through all seasons. The F-gas refrigerants are selected for each unique application/system based on a number of factors including energy efficiency, volumetric capacity, safety, flammability, toxicity, and environmental properties. With their unique properties, F-gases enable reliable, widespread, and safe food and pharmaceutical production, distribution & preservation as well as safe and efficient heating and cooling of buildings to support modern society's needs.

Fire Protection: Application is to effectively, efficiently, and safely extinguish a fire. F-gases are an active ingredient not auxiliary.

Are in your view the listed non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

HVACR: Non-PFAS alternatives cannot replace F-gases in all applications. While highly flammable hydrocarbons can be used in <1 kg charge, hermetically sealed, factory filled refrigeration appliances, they present a safety risk in larger systems. Ammonia results in numerous releases, evacuations, injuries, and fatalities so that use in occupied spaces presents unacceptable risk. Examples:

<https://bit.ly/TSSRef15>

<https://bit.ly/TSSRef16>

<https://bit.ly/TSSRef17>

<https://bit.ly/TSSRef18>

<https://bit.ly/TSSRef19>

CO₂ is non-flammable but has an acute exposure limit 2-3X lower than alternatives. Its low critical point and very high pressure in warmer climates leads to increased energy consumption, requiring additional components and controls.

Fire Protection: F-gases are only used where alternatives are not suitable. Inert gases are slow, have a large storage volume and can cause acoustic damage of hard drives. CO₂ is slow and toxic, dry chemical agents are not clean and are a health hazard.

Are in your view the listed non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

HVACR: A technology solution's feasibility needs to be assessed case by case. Viability of alternatives should address whether they meet the performance demands of an application while implemented on a broad scale to satisfy cooling/heating needs without increasing the total cost of ownership (TCO) or disadvantaging end-users. TCO needs to consider 1st cost of systems, installation, maintenance, energy and safety mitigation.

A recent report on alternative technologies concluded that low GWP HFO-blend solutions provide the best emission reduction & lowest life cycle costs for commercial refrigeration in food stores below 2000m²:

<https://bit.ly/TSSRef21>

Often reports of non-PFAS alternative costs only consider initial equipment cost and not costs required for proper maintenance & service.

Fire Protection: While installing alternatives may be cost efficient, their use may cause damage to the critical asset they protect. Resulting damage could cost more than the original installation savings.

Do you have information on the alternatives' risk profile?

Yes

Please describe.

HVACR: Risk profiles of highly flammable, Class 3 refrigerants (e.g. propane and iso-butane) and toxic, Class B (ammonia) alternatives are available in industry standards as well as in extensive flammability testing used to inform updating of industry standards. See:

<https://bit.ly/TSSRef22>

Fire Protection: Most alternatives are well known and have existed for decades (H₂O, CO₂, inert gases).

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

HVACR: F-gases used in the HVACR industry are already highly regulated via REACH, F-gas regulations, and the MAC directive. The Existing F-gas Regulation already provides reporting requirements, quota limitations, and a framework to address leak management, end of equipment life mgmt, training & certification, and enforcement. These existing elements can be further strengthened to include HFOs & achieve stronger enforcement mechanism to limit system emissions and enable circularity. In addition, F-gas technologies are critical in enabling the EU Green Deal and the deployment of the EU decarbonization program. If PFAS alternatives are the only options available to the industry, this will put this EU Green Deal target at risk. OEMs are also often required to follow lengthy qualification of any new substance in their systems.

Fire Protection: Fire protection systems have a variety of legal approval processes for their implementation & use such as: VdS(D), LPCB(UK), CEN fire standard (EU).

What is the average approval time?

HVACR: In applications where an alternative is deemed suitable, it can take 3-5 years for qualification of use of a new substance in a system, depending on the substance, application, etc.

Fire Protection: One to two years assuming toxicology data already exists.

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With that objective in mind, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

Based on previous experience, the process of invention, testing, manufacturing and commercialization may take between 10-15 years combined with a substantial financial investment.

Due to the complexity of applications, performance requirements, and extensive installed equipment, it is unrealistic to expect any single alternative to achieve a complete transition of an entire industry segment in any time horizon. Any claims otherwise would be a gross oversimplification of the industry's needs. It can take multiple decades from development of a new solution to broad adoption within even a sub-segment of the industry.

Do you have information on additional alternatives for any of the described applications that have not been disclosed in the attached information?

No

V. Questions - Section D - F-gas uses

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Limited impact. The Current F-gas regulation requirements already in place address issues such as leak detection/repair, recovery, reclaim and recycle throughout the systems' operating lifetime, including end-of life, ensuring minimal impact to the environment. Industry associations have recommended extending the F-Gas provisions on containment and recovery to all types of refrigerants, including HFOs and non-fluorinated alternatives. This would have numerous benefits in terms of environmental protection, safety and energy efficiency.

V. Questions - Section E - F-gas uses

Specific questions for the use

Within the following applications/uses, what are the barriers to the substitution from F-gases to fluorine-free alternatives, and how much time would it require to address those?

Barriers to substitution.

Commercial refrigeration, and specially alternatives to F-gases in mid to large scale facilities	• Existing equipment and systems with a lifetime expectation of +/- 15 years are not compatible with “fluorine free” alternatives due to performance requirements, operating pressures, flammability, and/or toxicity. • Increased energy consumption leading to higher cost and indirect emissions, especially in warmer climates. https://bit.ly/TSSRef14 • Toxicity and high flammability risks. • Cost and resource efficiency considerations
Transport refrigeration	• Reliability, performance, flammability and toxicity risk, high pressure, energy efficiency requirements
Mobile air conditioning in cars, vans and trucks	Please see Transport section
Foam Blowing Agent, both closed and open cell	Safety, flammability, thermal conductivity, dimensional stability of finished foams, shelf life of polyol blends, inability to meet building code requirements. Alternatives produce inferior foam products with greatly reduced performance and functionality.

Time required to address barriers to substitution.

Commercial refrigeration, and specially alternatives to F-gases in mid to large scale facilities	It is not simply a matter of time to address barriers to substitution; F-gases were developed over 85 years ago due to the shortcomings of the “fluorine-free” alternatives.
Transport refrigeration	It is not simply a matter of time to address barriers to substitution; F-gases were developed over 85 years ago due to the shortcomings of the “fluorine-free” alternatives.
Mobile air conditioning in cars, vans and trucks	Please see Transport section
Foam Blowing Agent, both closed and open cell	Currently it has already been 40 years

Is there any potential niches, systems or processes that would still rely on F-gas use in a 10-years perspective within the applications/uses mentioned above, but also in other ones, such as for example:

Reliance on F-gases in a 10-year perspective?

Industrial refrigeration	Yes, given the challenging and unique requirements of industrial refrigeration that can have process safety management implications and/or unique and very low temperature requirements, F-gases may be the only viable solution in some instances. The equipment in this sub-segment tends to be more customized design to achieve the desired process objective.
Domestic air conditioning and heat pumps for space heating	Yes, low GWP F-gases are the enabling technology with the lowest environmental impact for this application and are critical to meet EU decarbonization goals. Ref: (https://bit.ly/TSSRef23)
Commercial air conditioning and heat pumps	Yes. A manufacturers group representing >1000 companies (many SMEs) rejected the claim that hydrocarbons could replace F-gases in AC and heat pumps by 2030 as "completely unrealistic". (https://bit.ly/TSSRef23)
Solvents	Oxygen service cleaning solvent for aerospace & aircraft components and systems no replacement available. Ref. M.A. Mitchell 2017: https://ntrs.nasa.gov/api/citations/20170010148/downloads/20170010148.pdf
Propellants (non-MDI)	No answers
Electronic cooling	1 & 2 Phase immersion cooling for Hyperscale and edge data centers, Enterprise HPC, and 5G networks, where only fluorinated fluids can meet the electrical compatibility requirements.
Other (please specify in the field to the right)	In-situ spray foam, appliance foam, XPS foam, high pressure spray foam applications (closed cell); low pressure spray foam application (closed cell) Working fluids for organic rankine cycle processes and high temperature heat pumps

Do you have information on the use of F-gases apart from the ones considered so far (heating/ventilation/air conditioning/refrigeration, foam blowing agents, propellants, solvents, fire suppression, and as cover gas), like e.g. in electronics cooling/data centers or use as solvents in 3D printing?

Yes

If so, please provide information on substance ID, function, PFAS concentrations and market information for such applications.

Emerging technologies such as data-center immersion cooling and 3D printing will continue to grow as we move forward.

For data center immersion cooling – 100% of HFE7100, HFC-4310mee, FC-3284, FC-3284, Galden HT55, and HT70 is used as a cooling fluid.

For 3-D printing – 1% to 10% of Methoxytridecafluoroheptene isomers (REACH Reg # 01-2119943760-37-0000) is used as a solvent-based debinding system in commercial critical cleaning solvent.

References:

<https://liquidstack.com/liquidstack-resources/liquid-cooling-data-center-sustainability-whitepaper>

<https://miller-stephenson.com/3d-printing-solvents/microforged-3d-printer-solvent/>

<https://markforged.com/3d-printers/metal-x>

V. Questions - Section B - Electronics & energy

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary electronics and energy july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (-/-0/+ /++) ¹	Emissions/year in EEA (tonnes/PFAS)
Electronics industry and semiconductor	Non-Polymers: 1,200 Polymers: 3,100 Total: 4,300	++	Production: 700 Use: 20 Recycling / waste: 900
Semiconductor	Non-Polymers: 85 Polymers: 1,400 Total: 1,485	++	
Energy industry	Non-Polymers: 250 Polymers: 1,200 Total: 1,450	++	Production: 40 Use: 1 Recycling / waste: > 24
Batteries	Polymers: 15,000	++	Production: ? Use: ? Recycling: ?

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

Do you have information that indicates that the information provided on the tonnage should be adjusted?

No

Do you have information that indicates that the information provided on the emissions should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

Systems should be designed to reduce fugitive emissions and industry is developing hermetic systems. New technologies continue to be developed to improve the system efficiency. "Ecoenergetic Comparison of HVAC Systems in Data Centers A. F. Santos et al." provides a good example of best F-gases uses. Novel systems using immersion cooling helps developing smaller equipment footprint and a significantly smaller environmental footprint.

Benefits of F-gases in immersion cooling include the possibility for recycling and circular-use.

Novel Two-phase cooling systems must be hermetic to maintain the evaporative phase. From an overall energy efficiency perspective, the choice of cooling technology should not just be based on cost and heat dissipation rates, but also on the potential for waste heat utilization (<https://bit.ly/TSSRef24>).

Another example within the EEA energy industry in high voltage equipment: <https://bit.ly/TSSRef25> page 7.

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

No information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

No

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

As stated above, specifically for two-phase liquid immersion cooling systems, the systems can be designed to reduce the fugitive emission and industry is developing hermetic systems. Technology is still emerging and being developed to reduce the amount of fluid. As a result, F-gases used in immersion cooling could be recycled or repurposed as part of circular economy.

Improvements in equipment design will also reduce risks. For example, airless/vacuum vapor degreasers are designed to operate and distill solvent under reduced pressure. The typical emission of Type-V degreasers to air is negligible, << than 1-100g/h in Type IV machines. [1] ESCA Classifications of surface cleaning machines.

<https://bit.ly/TSSRef26>

V. Questions - Section C - Electronics & energy
Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Electronics industry and semiconductor	For fluoroelastomers in sealing: ethylene propylene diene monomer (EPDM) and silicone rubbers
	For wire insulation: silicone materials
	Polyetheretherketone (PEEK)
	For photolithography (hard and not for all applications): hydrocarbon-based greases, Molybdenum disulfide, graphite

Sub-Use	Non-PFAS alternatives
Energy industry	For fluoropolymer-based backsheets for photovoltaic cells polyolefin could be an alternative. Other fluorine free backsheets made of polyethylene terephthalate (PET) and/or ethylene vinyl acetate (EVA) can/are also used For cables: Mica and EPDM For seals: Hydrocarbon elastomers For batteries :Solid-state batteries For fuel cells: For PEM membranes: Hydrocarbon membrane and sulphonated polyetheretherketone (PEEK) Reinforcement material as alternative to PTFE: Electrospun polybenzimidazole-type materials For sealings: Some elastomers without fluorine exist and could potentially be used in the future for the Membrane Electrodes Assembly (MEA) function For immersion cooling: Synthetic oil

What is the specific application/functionality of PFAS in your product(s)/processes?

PFAS are used for critical cleaning solvents (vapor degreasing) for aerospace, aircraft, military, medical, electronic parts, and components. PFAS are also used in 1-phase heat transfer fluids for semiconductor manufacturing and immersion cooling and 2-phase immersion cooling fluid for IT data center. Solvents containing PFAS are used for cleaning parts that are used in an oxygen-enriched environment. Parts and components used in these industries must be completely reliable throughout their designed lifetime and must meet the strictest cleaning and safety standards. If parts are not properly cleaned, it can affect the subsequent downstream fabricating processes, failure can be catastrophic, and with possible loss of lives. PFAS such as Sulphur hexafluoride (SF6) is also used as an insulation gas for transformers and switchgear.

Are in your view the listed non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

TCE, nPB, PERC, and DCM are the closest alternatives but are extremely toxic and are being phased out. nPB has an ODP value of 0.018. The surface tension of aqueous cleaning agents is too high which prohibits its effectiveness in cleaning small and complex parts. Aqueous cleaning agents are also corrosive to metals, have high energy costs, and require extensive wastewater treatment, and there are irregular water disposal practices across end-users.

Organic solvents (HC, alcohols, esters, and ketones) are flammable, some are VOC air pollutants, have limited solvency (low Kb values) and are not suitable for oxygen service cleaning applications. Volatile Methyl Siloxanes are persistent & bioaccumulative.

tDCE alone is flammable and requires at least 5% concentration blend of the PFAS solvent. S-critical CO2 requires a pressure vessel that limits the size of the part and has safety and contamination concerns.

Eurostat: <https://bit.ly/TSSRef1>

<https://bit.ly/TSSRef2>

Are in your view the listed non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

None of the non-PFAS alternatives can replace the fluorinated solvents in critical cleaning applications. They do not possess all the requirements of critical cleaning. It will force users to switch to unreliable and unproven cleaning agents and processes which can lead to catastrophic failure. For use of low-flashpoint flammable solvents, explosive-proof equipment will be required which significantly increases the capital, operation and energy costs, reduces throughput, and produces poorer results. This will force small and mid-size operators out of business as the cost of production will be much higher than foreign competitors.

Do you have information on the alternatives' risk profile?

Yes

Please describe.

nPB, TCE, PER, DCM toxicity profiles are available on authorities' websites worldwide, including ECB, EPA, WHO, and CDC and industrial organizations such as ACGIH (American Conference of Governmental Industrial Hygienists). Risk profiles of flammable solvents are readily available through various government, industrial organizations, and chemistry textbooks.

<https://bit.ly/TSSRef3> (nPB)

<https://bit.ly/TSSRef4>

<https://bit.ly/TSSRef5> (TCE)

<https://bit.ly/TSSRef6> (TCE)

<https://bit.ly/TSSRef7> (PERC)

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

You will find below specific literature references to this question:

<https://bit.ly/TSSRef3>

<https://bit.ly/TSSRef27>

<https://bit.ly/TSSRef28>

<https://bit.ly/TSSRef4>

<https://bit.ly/TSSRef29>

What is the average approval time?

Seeking approval of these toxic substances in vapor degreasing will depend on EU regulatory authorities; however, an estimated 1 to 5 years should be expected.

The use of flammable cleaning agents will require the approval of competent authorities in EU Member States, which may take up to 3 years. Aqueous cleaners generate a large amount of wastewater stream which requires extensive treatment before discharge. Permits from local authorities will be required and approval times may take up to 2 years.

<https://bit.ly/TSSRef30>

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With this objective in mind, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

Based on previous experience, the process of invention, testing, manufacturing and commercialization may take between 10-15 years combined with a substantial financial investment.

Do you have information on additional alternatives for any of the described applications that have not been disclosed in the attached information?

No

V. Questions - Section D - Electronics & energy

Questions in relation to impact of legislative measures (for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Limited impact. The Current F-gas regulation requirements already in place address issues such as leak detection/repair, recovery, reclaim and recycle throughout the systems' operating lifetime, including end-of life, ensuring minimal impact to the environment. Industry associations have recommended extending the F-Gas provisions on containment and recovery to all types of refrigerants, including HFOs and non-fluorinated alternatives. This would have numerous benefits in terms of environmental protection, safety and energy efficiency.

Most PFAS solvents are used in airless/vacuum vapor degreasing systems, >99% of the PFAS solvents are distilled and reused. The remaining residues need to be safely collected and disposed of by authorized waste treatment companies. Containers with remnant solvent should also be disposed of as hazardous waste.

V. Questions - Section E - Electronics & energy

Specific questions for the use

In case available, please provide information on concentration of PFAS in electronic, semiconductor and energy final products:

Carrier fluids are used to dissolve/solvate adhesive ingredients so they can be applied (e.g. spray, brush, roll) onto the contact surface of two substrates to adhere them together and are not present in the final products.

F-gases provides a nonflammable, lower toxicity, fast drying, effective alternative to methylene chloride (MeCl₂), toluene, TCE, n-PB and other carrier fluids/solvents.

For electric vehicles' batteries thermal management, although the technology is still under development, it is estimated for immersion cooling for electric vehicle batteries that the concentration would be roughly 2-3% from origination until end of life.

V. Questions - Section B - Transportation

Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary transportation july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have any information available. Input to fill these gaps is highly appreciated.

Sub-Use		Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0 /+/++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Body-, hull and fuselage construction		?	0	?
Sealing applications		111,104 (fluoroelastomers in road transportation vehicles)	0	?
Lubrication		?	0	?
Hydraulic fluids		?	0	?
Electrical engineering and information technology		?	++	?
Coating and finishings (incl. textiles, interiors and related applications, e.g. coating of trim materials)		?	+	?
HVACR systems (heating, ventilation, air conditioning and refrigeration)	F-gases in road transportation vehicles	184,130	+	9,000
	F-gases in systems in trains/ships/aircrafts	?	+	?
	F-gases in systems for transport refrigeration	10,926	+	495.8
Health protection and lifesaving equipment (incl. firefighting, life vests, life rafts, airbags, ...)		?	+	?

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions relate to mixture/article production and mixture/article use. They do not include PFAS production and the waste stage of the articles. These emissions are covered in a separate section.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

No

Do you have information that indicates that the information provided on the emissions should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

The Mobile Air Conditioning emission per year should be 3,006 MT/year due to a lower refrigerant leakage rate.

Calculation is based on amounts of PFAS in HVACR-systems (ca. 0.6 kg/personal vehicle, ca. 1 kg/unit per truck and ca. 6 kg/unit per bus) and taking into account the total number of registered passenger cars (242,727,242), trucks (sum of light and heavy commercial vehicles: 34,340,233) and busses (692,207) in the EU (ACEA 2019) it can be assumed that a total amount of approx. 180,000 t of F-gases are used in HVAC-systems for passenger comfort in road traffic in EEA. Based on an average leakage of 10g/vehicle per year (see David Sousa – Pastel 2009) with a charge size of 0.6kg, this equates to a leakage rate of 1.67%. $180,000 \text{ MT} \times 1.67\% = 3,006 \text{ MT}$ emissions in EEA per year.

Source (page 21, paragraph 1.3 System and components emissions level):

<https://bit.ly/TSSRef31>

<https://bit.ly/TSSRef32>

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

no information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

Yes

Please specify and/or refer to literature/public sources.

Total light vehicle sales for new vehicles in EEA are not projected to increase after 2023 (IHS 2018, p8). Also, new technologies that will promote car sharing (e.g. autonomous driving will reduce car ownership) have not been factored in. After 2023, the EEA will have a stable fleet size for light vehicles (light vehicles use ~80% of total refrigerant in mobile air-conditioning, see previous question for calculation). For trucks and trailers (much smaller in total market size) the estimated new production CAGR is approx. 1% after 2023 (Roland Berger 2018, p30 & 31). Only very limited further growth in the annual production of PFAS (in total tonnes per year) is expected after 2023. Hybrid and electric vehicles require a hermetic electric compressor which considerably facilitates the refrigerant containment (Pastel 2009, p31). The outlook should therefore be 0.

Ref: IHS 2018: <https://bit.ly/TSSRef33>
 Ref: Roland Berger 2018: <https://bit.ly/TSSRef34>
 Ref: Pastel 2009: <https://bit.ly/TSSRef31>

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment for your application of PFAS?

Yes

Please specify and/or refer to literature/public sources.

- ☐ During the production process of R-1234yf, vapor waste is captured and incinerated at a very high temperature through a thermal oxidizer.
- ☐ The automotive industry is actively developing technologies to detect leakage working closely together with R-1234yf recovery machine suppliers. See links attached.
- ☐ Exposure to workers is regulated by handling and maintenance & repair procedures.
- ☐ Exposure to consumers is essentially limited to mechanical accidents.
- ☐ MAHLE Service Solutions | SAE Certified ACX1280 R1234yf Recovery Machine Continues to Gain Great Customer Feedback and Industry Award (<https://bit.ly/TSSRef35>)
- ☐ New Robinair air conditioning service unit for R1234yf refrigerant - Bosch Media Service (<https://bit.ly/TSSRef36>)
- ☐ Reference: SAE, 2016 SAE standards point way to service of R-1234yf systems: <https://bit.ly/TSSRef37>

V. Questions - Section C - Transportation

Questions in relation to alternatives (mainly for individual companies)

Sub-Use	Non-PFAS alternatives
Body-, hull and fuselage construction	?
Sealing applications	?
Lubrication	?
Hydraulic fluids	?

Electrical engineering and information technology	?
Coating and finishings (incl. textiles, interiors and related applications, e.g. coating of trim materials)	- silicone based chemicals - sulfosuccinates - propylated aromatics - fatty alcohol polyglycol ether sulphates - alkyl acrylates - polyurethanes and -acrylics
HVACR systems (heating, ventilation, air conditioning and refrigeration)	- air - water - ethylene glycol - mineral oils - silicone oils - alcohols - natural gases: HC-600 (n-butane), R-717 (Ammonia), R-744 (CO₂)
Health protection and lifesaving equipment (incl. firefighting, life vests, life rafts, airbags, ...)	?

What is the specific application/functionality of PFAS in your product(s)/processes?

The main MAC fluids are R-134a and R-1234yf. R-1234yf was developed specifically for MAC. Selecting HFO-1234yf was based on assessments of its environmental effects, objective comparisons of its technical performance and an evaluation of its safety in use as it is a mildly flammable A2L refrigerant. It has a 100-year GWP of <1 versus R-134a at 1300 (IPCC AR5), which is a 99.9% reduction. Due to the close performance match between both refrigerant solutions, the auto industry transitioned smoothly to use R-1234yf in millions of vehicles with an immediate positive environmental impact.

F-gases are used in the vast majority of Transport Refrigeration equipment (trucks & trailers, sea vessels, trains, marine containers, airfreight containers, etc.).

Fire protection: F-gases are used as fire suppression systems in military applications, commercial aviation, and other critical installations. Main requirements are electrical non-conductivity, non-corrosive, & low residues after utilization.

Are in your view the listed non-PFAS alternatives technically feasible in your product(s)/processes?

No

Please specify why.

The alternatives fail to offer an effective and efficient air-conditioning (AC) functionality at a wide enough ambient temperature range. For example, CO₂ does not operate effectively (from a technical perspective) in hot climates where the AC is operated for longer periods. The AC efficiency of the vehicle will be severely compromised (requiring significant modifications to the hardware of existing AC systems) and the AC system will require more energy to cool the cabin to ambient temperature. (Papasavva, 2014 P8 para 7: <https://bit.ly/TSSRef38>)

Current generation equipment can hardly allow refrigerant change without substantial re-design efforts.

Fire protection: Not-in-kind alternatives tested for aviation use failed to pass the minimum performance standards. Restricting fire protection F-gases, would severely impair the aviation industry efforts to replace halons and continue to provide safe transportation.

Are in your view the listed non-PFAS alternatives economically feasible in your product(s)/processes?

No

Please specify why.

R-134a and R-1234yf refrigerants are highly efficient at transporting heat at high and low temperatures. For MAC, alternatives like CO₂ require more expensive compressors, hoses and more energy to operate due to the increased pressure to establish a working system. This increases weight and cost for the total air-conditioning system and lowers technical performance (especially at >30°C). Life Cycle Climate Performance studies concluded that R-1234yf is most effective across all ambient temperatures (Papasavva 2014, p8 para 7 & p9, para 9). For transport refrigeration, equipment is often designed to function with R-134a and R-404A. The industry has shifted to R-1234yf as a lower GWP alternative. Non-PFAS alternatives like Hydrocarbons or CO₂ are either incompatible with application requirements (flammability risk on sea vessels, airplanes & trains) or too complex and/or expensive to cover specification requirements (CO₂ for reefer containers, Trucks, & Trailers). <https://bit.ly/TSSRef38>

Do you have information on the alternatives' risk profile?

Yes

Please describe.

CO2 is challenging in automotive air conditioning because its pressure is 10x higher than R-1234yf and HFC-134a (Papasavva, 2014 P 8, para 7). It is difficult to contain CO2 in the flexible hoses needed in vehicles to manage vibration during use. A CO2 system leak can lead to high levels of CO2 in the cabin that is not easily detected when inhaling, which could be deadly. The pressure in an HFO system is 10x lower, hence the amount of refrigerant that can leak into the cabin is much lower. With refrigerated transport, hydrocarbons are also challenging due to flammability, which has precluded their use in several key refrigerated transport applications (i.e. reefer containers, air transport, sea refrigerated vessels & railways wagons). Butane is highly flammable and has a higher boiling point (app. 0°C) vs R-1234yf, making it difficult to use in all geographies under norm conditions. The pressure will be too low to offer sufficient thermodynamic performance.
<https://bit.ly/TSSRef38>

Are there legal approval schemes for your product(s)/processes, which have to be taken into account in case PFAS alternatives will be used?

Yes

Please specify and/or refer to literature/public sources.

Vehicle road-worthy and safety legislation (type approval) ensures a safe usage of our products in automotive applications. Our customers (the OEMs) go through a rigorous development and test program to demonstrate compliance. Obtaining legal approval for a technical feasible alternative to R-134a and R-1234yf outside the F-gas Regulation starts with ASH-RAE registration and is followed by vehicle road-worthy and safety legal approval (type approval).
 For flammable refrigerants, compliance with ATEX requirements is mandatory. Certain regions/jurisdictions require a Risk Assessment to be completed before installation.
<https://bit.ly/TSSRef39>
<https://bit.ly/TSSRef40>

What is the average approval time?

Transport: ASHRAE registration: typically, ~12 months
 Vehicle type approval: typically, ~24-48 months after ASHRAE registration.

Consideration should also be given to the timeframe required to allow continued F-Gas supply for servicing. An example could be taken from article 6 of the MAC directive (Directive 2006/40/EC), where the provision allowed for an overall period of about 11 years (since the directive adoption in May 2006 until January 1st, 2017) the retrofitting and refilling of vehicles.

Do you actively work on finding alternatives?

Yes

Please specify.

To produce the next generation of innovative chemistry products, we invest in research and development ("R&D") in order to develop safer, cleaner, and more efficient products and processes that enable our operations, customers, and consumers to reduce their greenhouse gas ("GHG") emissions, carbon footprint, and overall environmental footprint. With this objective in mind, we recently opened our new 312,000-square-foot R&D facility on the Science, Technology, and Advanced Research campus of the University of Delaware in Newark, Delaware ("Chemours Discovery Hub"), USA.

As the future architecture of vehicles changes, Chemours is actively developing blend technologies to be deployed side by side with R-1234yf and complement the electrical vehicles market.

If alternatives have been identified as potentially suitable, which timescale do you foresee for a complete transition to those? Please explain.

Based on previous experience, the process of invention, testing, manufacturing and commercialization may take between 10-15 years combined with a substantial financial investment. The developments of new HFO chemistry as an alternative to R-1234yf is at its early stages. Chemours expects a first vehicle type approval beyond the next 5 years. Based on the R-1234yf market experience, we estimate that a full market transition (all OEMs have type approved their vehicles with an HFO alternative to R-1234yf will likely take >15 years).

Do you have information on additional alternatives for any of the described applications that have not been disclosed in the attached information?

No

V. Questions - Section D - Transportation

Questions in relation to impact of legislative measures
(for companies and industry associations)

What is the economic impact (in euro) and social impact (e.g. jobs) on your business/company if the use of PFAS is prohibited?

a) In 3 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than €1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

b) In 10 years.

Given widespread use of F-gases, and lack of acceptable alternatives, there is likely a multi-billion-euro impact in the broader value chain. Negative cross regional impacts such as disrupting long term supply agreements or impact on production assets in other regions, further limiting Europe's access to critical materials, could occur. Assuming no derogations, other regulatory exemptions, or determinations of "essentiality", a prohibition on the use of PFAS, as defined in the July 15, 2021, Registry of Intention, in the F-gases industry could result in greater than € 1B revenue losses on an annual basis in the EEA and greater than 500 European jobs could be directly impacted. Chemours TSS business had global net sales of \$1.1B and \$1.3B in 2020 and 2019, respectively, and had net sales in Europe, the Middle East, and Africa of \$331M and \$408M in 2020 and 2019, respectively, reported in its 2020 Annual Report.

Source: <https://bit.ly/TSSRef41>

c) Please explain by providing your calculations.

Net sales numbers as reported in Chemours Annual Report on Form 10-K for the year ended December 31, 2020.

Full time equivalent impact was estimated based on customary minimum support for associated sales.

The definition of PFAS, stated in the July 15, 2021, Registry of Intention, was used without exceptions. It was assumed the regulatory process would result in no derogations or other regulatory exemptions or determinations of any product use as "essential".

What is the economic impact (euro) on your business/company, if the following measures will become mandatory? Please make your (indicative) calculations transparent.

a) A maximum concentration of e.g. 0.1% (or less) PFAS is set in mixtures and/or articles.

PFAS concentration varies, but in general is greater than 0.1% of the formulation. Therefore, this measure leads to a complete ban leading to the same economic impact as stated above.

b) Obligation to label your products visibly with "Contains PFAS".

Labeling regulations will have limited economic impact, although it could imply an investment in the redesign and reprinting of current packaging labels. All of our products already have labeling requirements as this is already required under existing F-gas regulation (EU) 517/2014.

c) Obligation to report amount of PFAS in use and respective emissions.

Given the widespread usages of F-gases across the value chain, it would be important to determine at what stage reporting requirements are set. Depending on requirements, the administrative burden can vary significantly, hence the economic impact.

Reporting requirements already exist for the quantity of F-gases placed on the market by quota holders and GHG emissions reporting by Member States which includes F-gases reported by sector. F-gas regulations also already require leak management and end of life management reporting for service technicians and equipment owners. These requirements pertaining to product circularity can be strengthened further via the F-gas revision process that is already underway.

d) Specific waste management requirements with the obligation to collect, treat or recycle PFAS containing waste separately.

Limited impact. The Current F-gas regulation requirements already in place address issues such as leak detection/repair, recovery, reclaim and recycle throughout the systems' operating lifetime, including end-of life, ensuring minimal impact to the environment. Industry associations have recommended extending the F-Gas provisions on containment and recovery to all types of refrigerants, including HFOs and non-fluorinated alternatives. This would have numerous benefits in terms of environmental protection, safety and energy efficiency.

Chemours is already applying rigorous waste management requirements and working with the Automotive OEMs and Aftermarket (e.g. equipment manufacturers for garages to recharge refrigerants) to reduce unintended releases of refrigerants.

Annex I of the EU Directive 2000/53/EC on vehicles end of life covers the waste management of gases used in the vehicles air-conditioning systems.

V. Questions - Section E - Transportation

Specific questions for the use

For this restriction proposal the assessment of the transportation sector encompasses: road traffic, ships, trains and aircrafts. We identified the following applications of PFAS in the transportation sector:

- 1.) Body-, hull and fuselage construction
- 2.) Sealing applications
- 3.) Lubrication
- 4.) Hydraulic fluids
- 5.) Electrical engineering and information technology
- 6.) Coating and finishings (incl. textiles, interiors, and related applications e.g. coating of road signs)
- 7.) HVACR systems (heating, ventilation, air conditioning and refrigeration)
- 8.) Health protection and life saving equipment (incl. fire prevention and fire fighting)

Are there legal and/or industry standards in place in your industry that could no longer be met when the use of PFAS is no longer possible?

Yes

What would be a realistic timeframe and realistic costs in case standards need to be adjusted?

Vehicle road-worthy and safety legislation (type approval) ensures a safe usage of our products in automotive applications. Our customers (the OEMs) go through a rigorous development and test program to demonstrate compliance. Obtaining legal approval for a technical feasible alternative to R-134a and R-1234yf outside the F-gas Regulation starts with ASH-RAE registration and is followed by vehicle road-worthy and safety legal approval (type approval).

For flammable refrigerants, compliance with ATEX requirements is mandatory. Certain regions/jurisdictions require a Risk Assessment to be completed before installation.

<https://bit.ly/TSSRef39>
<https://bit.ly/TSSRef40>

Transport: ASHRAE registration: typically, ~12 months
Vehicle type approval: typically, ~24-48 months after ASHRAE registration

The approximate cost may be in the multiple billion Euros range for the entire EEA industry.

V. Questions - Section B - Waste
Questions in relation to the use (mainly for industry associations)

The following linked information presents the current picture: [Report summary waste july 2021.pdf](#)

In the tables presented on this page and the following, '?' in the cells show that the authorities do not have

any information available. Input to fill these gaps is highly appreciated.

Sub-Use	Tonnage (tonnes/PFAS) per year in the EEA	Expected trend (--/-/0/+/>++) ¹	Emissions/year in EEA ² (tonnes/PFAS)
Textiles/TULAC	43,605	++	WWTP: 3.5 (median) Landfill: 1.8 (median) Incineration: Flue gas: ? Bottom ash: 0.03 Fly ash: 0.05
Food contact material (paper & board)	2,894	+	
End-of-life-vehicles (ELV)	2,219	+	
Waste electrical and electronic equipment (WEEE)	?	++	
Sewage sludge	0.404	?	0.3

¹ -- = strong decrease, - = decrease, + = increase, ++ = strong increase, 0 = neutral

² Emissions only relate to the waste stage. They do not include mixture/article production, mixture/article use and PFAS production. These emissions are covered in the other sections of this survey.

Do you have information that indicates that the information provided on the tonnage should be adjusted?

No

Do you have information that indicates that the information provided on the emissions should be adjusted?

No

The environmental release category (ERC) is a key REACH use descriptor to define the release factors of a chemical substance in a specific use exposure scenario. It is used in various modelling tools to derive environmental exposure estimates. ERC default factors are used to estimate emissions of PFAS in three major life-cycle stages, namely the production stage including manufacture of substances, formulation of mixtures and production of articles, the 'in-use' stage, and the waste stage.

Please indicate if you have information on specific emission values (SPERCs) for (groups of) PFAS, based on measurements and / or model calculations.

No information

Do you have information that indicates that the information provided on the expected trend should be adjusted?

No

Do you have information on risk management measures to minimize the use, human exposure and emissions to the environment?

No

V. Questions - Section E - Waste

Specific questions for the use

If available, please provide data on PFAS (or total F) measurements in flue gas, fly ash or bottom ash from waste incinerators (Energy from Waste installations, cement kilns, hazardous waste incinerator etc.).

The Chemours Netherlands Dordrecht site (CC-NL) is a BRZO company (NL version of EU Seveso guidelines). Permits for BRZO companies include Best Available Technologies (BAT) requirements, also for their emissions to the environment. The BRZO locations in NL are strictly monitored by the NL authorities.

The permits are available at the authorities (DCMR).

CC-NL has installed BAT. This includes a thermal converter (TC), since the mid-90's to treat unwanted fluorinated gaseous by-products now considered PFAS under the current broad definition.

The TC converts waste gases from the production facilities into a solution of HF in water. The fluorinated gaseous by-products are converted at a temperature of about 1150 °C by combustion of natural gas. The TC is converting at least 95% for the different feed streams. The remainder is safely emitted according permit requirements.

Chemours is investing in further emission reduction projects in line with the ambitious 10x2030 CRC goals announced in 2018.

Thank you for your participation!

This is the last page of the survey. Please make sure your information is correct. After clicking on 'Submit', you will not be able to change your entries anymore. The following page however will give you the opportunity to save your answers as PDF document or print them.