

CHEMICAL SAFETY REPORT

PROVIDED AS COMMENTS TO THE PUBLIC CONSULTATION ON THE REACH RESTRICTION PROPOSAL ON PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

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Abbreviations

AoA	Analysis of Alternatives
CSR	Chemical Safety Report
ECTFE	Ethylene, chlorotrifluoroethylene copolymer
ETFE	Polyethylene-cotetrafluoroethylene
FEP	Perfluorinated ethylene propylene; Ethylene, Chlorotrifluoroethylene, hexafluoroisobutylene terpolymer; Polytetrafluoroethylene-cohexafluoropropylene
FKM/FFKM	<i>Fluorkautschuk</i> / Fluorine rubber / Fluorocarbon-based fluoroelastomer
FPs	Fluoropolymers
FVMQ	Fluorosilicone
HVAC	Heating, ventilation, air conditioning
LEV	Local Exhaust Ventilation
PFA	Perfluoroalkoxy polymer
PFAS	Per- and polyfluoroalkyl substances
PFPEs	Perfluoropolyethers
PLC	Polymers of low concern
PPE	Personal Protective Equipment
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene fluoride
PVDF-HFP	Vinylidene fluoride, hexafluoropropene copolymer
SCFPs	Side-chain fluorinated polymers
SEA	Socio-economic Analysis
WWTP	Wastewater treatment plant

Chemical Safety Report

1. INTRODUCTION

This comment is submitted in the name of figawa e.V.¹, the German association of companies for gas and water technologies supported by DGMT e.V.² (German Society for Membrane Technology) and Aqua Europa AISBL³. Our members provide products and services for the utilisation and distribution of gas and liquid fuels as well as the distribution and the treatment of drinking water and water for industrial and municipal purposes including wastewater and pool water treatment.

figawa has more than 275 member companies, which generate around EUR 34 billion of revenues annually. As an industry association, we bring together interests and advocate for standardized regulations and legislative processes to ensure long-term legal and planning certainty for all market participants. With our expertise, technology, and open dialogue, we aim to drive progress and innovation in our industries. Cross-cutting issues, as well as needs and requirements of our members are addressed in our industry aligned sector coordination groups.

The figawa members have aligned into three clusters based on the presence of PFAS in their product portfolio and applications to provide comments for the PFAS restriction proposal. These clusters are:

- Water treatment (drinking water, wastewater, industrial water, water reuse, and pool water)
- Water supply (public infrastructure, water distribution in buildings and water measurement, distribution of thermal energy) and
- Gas & liquid fuels (application and distribution)

To fulfil their responsibility of providing millions of private households, municipalities and industry with resources such as gas, oil, and water, our members depend on a variety of fluoropolymer-based technical components, all of which with high requirements towards their mechanical and chemical properties. This does not only guarantee a functioning infrastructure with an enormous economic impact on the European society but also the very safety of the European population.

It is important to note that figawa members and the contributing DGMT members are not manufacturers of per- and polyfluoroalkyl substances (PFAS) or polymer PFAS raw material⁴. They mainly assemble end-products from components and are only a part of the supply-chain. They are thus not directly involved in the development process of PFAS-free alternatives, which exhibit the complex set of physicochemical properties required for their products. It is additionally worth noting that due to the members' position in the supply chain, the exact composition of components in relation to PFAS is often unknown to them.

Under this premise, the members identified that polymeric PFAS are of extraordinary importance for the safe and durable operation of their products, and to fulfill the high

¹ <https://figawa.org/>

² <https://www.dgmt.org/the-dgmt.html>

³ <https://aqua-europa.eu/>

⁴ In general, the DGMT does contain members that are manufacturers of (polymeric) PFAS

requirements set out in various standards (cf. AoA/SEA report submitted along with this CSR, section 1.2). Polymeric PFAS may be categorized into three groups: Fluoropolymers (FPs), Perfluoropolyethers (PFPEs), and Side-Chain Fluorinated Polymers (SCFPs) (ECHA *et al.*, 2023a; Korzeniowski *et al.*, 2023). Of these three classes, FPs including fluoroplastics (e.g., polytetrafluoroethylene (PTFE) or polyvinylidene fluoride (PVDF)) and fluoroelastomers (e.g., fluorine rubber (FKM)) are the most important for the figawa members (**Table 1**). This is also reflected by the first comment submitted by figawa, in which a time-unlimited derogation for FPs was proposed⁵. The importance of FPs for the members' products becomes apparent when analyzing the components used for the manufacture of their end-products (see section **3.2**).

According to reports by Wood (2022), the total market volume of FPs sold in the EEA in 2020 was 40,000 tons, and PTFE makes up more than 50 % of the market (European Environment Information and Observation Network (EIONET) *et al.*, 2021). As summarized by Henry *et al.* (2018), PTFE combined with fluorinated ethylene propylene (FEP), polyethylene-cotetrafluoroethylene (ETFE) and other TFE-copolymers (e.g., perfluoroalkoxy polymer (PFA)) correspond to 70 to 75 % of FPs consumed worldwide. FPs are famed for their physico-chemical properties: They have a high chemical and thermal stability; their photochemical, oxidative, hydrolytic and biological stability is also high, which contributes to making them durable and resistant to weather (Henry *et al.*, 2018; Korzeniowski *et al.*, 2023).

Furthermore, FPs have been considered to be polymers of low concern (PLC) according to criteria that were discussed by the OECD (2009). Henry *et al.* (2018) applied the PLC criteria to four FPs – including PTFE, ETFE and FEP – and found the polymers in accordance with the concept. Similarly, Korzeniowski *et al.* (2023) extended the analysis to further FPs and included not only fluoroplastics but also fluoroelastomers. PFPEs contain similar properties as FPs as they are exemplarily described by manufactures as thermally and chemically stable with good dielectric properties, depending on the product⁶. However, PFPEs have not been covered in the PLC analysis cited above.

figawa members are not in all cases aware of the composition of components which are purchased on the open market. A reason for this may be that manufacturers do not disclose the formula of their products as they are recognized as confidential business information. As such, the content or type of PFAS has often been reported to be unknown in a questionnaire issued for this report. Disregarding potential unknown PFAS in components, specific nominations of PFPEs and SCFPs were only made in individual cases. Due to these reasons, the groups PFPEs and SCFPs were not excluded. However, it is highlighted that FPs are considered the most important polymeric PFAS for figawa members. In accordance with the first submission made by figawa, the main focus is therefore put on FPs when analyzing potential emission sources during manufacture, use and end-of-life phase of products.

⁵ Comment 4433 from 2023-06-02 accessible via <https://echa.europa.eu/documents/10162/8d917581-7faf-4e1a-26d4-073d52b3406e> (last accessed 2023-09-15)

⁶ See e.g., <https://www.solvay.com/en/brands/fomblin-pfpe-lubricants/properties> (last accessed 2023-09-13) or <https://www.solvay.com/en/brands/galden-pfpe/properties> (last accessed 2023-08-29)

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Table 1: Polymeric PFAS used by figawa members

Short name	Name	CAS	Group	Class	PLC
PTFE	Polytetrafluoroethylene	9002-84-0	Fluoropolymers	Fluoroplastics	Yes
PVDF	Polyvinylidene fluoride	24937-79-9	Fluoropolymers	Fluoroplastics	Yes
PVDF-HFP	Vinylidene fluoride, hexafluoropropene copolymer	9011-17-0	Fluoropolymers	Fluoroplastics	Yes
ETFE	Polyethylene-cotetrafluoroethylene	25038-71-5; 68258-85-5	Fluoropolymers	Fluoroplastics	Yes
ECTFE	Ethylene, chlorotrifluoroethylene copolymer	25101-45-5	Fluoropolymers	Fluoroplastics	Yes
	Ethylene, chlorotrifluoroethylene, hexafluoroisobutylene terpolymer	54302-04-04	Fluoropolymers	Fluoroplastics	Yes
FEP	Polytetrafluoroethylene-cohexafluoropropylene	25067-11-2	Fluoropolymers	Fluoroplastics	Yes
FKM	1-Propene,1,1,2,3,3,3-hexafluoro-polymer with 1,1-difluoroethylene copolymer and terpolymers	9011-17-0; 26425-79-6; 25190-89-0	Fluoropolymers	Fluoroelastomers (Fluorocarbon)	Yes
FFKM	Tetrafluoroethylenetrifluoromethyltrifluorovinylether copolymer	26425-79-6	Fluoropolymers	Fluoroelastomers (Fluorocarbon)	Yes
FVMQ	Fluorosilicone	—	Fluoropolymers	Fluoroelastomers (Fluorosilicone) ¹⁾	n/a
PFPE	Per- and polyfluoropolyethers	—	Per- and polyfluoropolyethers	—	n/a
—	Fluorinated acrylate polymer	—	Side-chain fluorinated polymers	—	n/a

Note: Information summarized from Henry et al. (2018), Letcher et al. (2020), Eionet (2021), ECHA (2023a), Korzeniowski et al. (2023)

¹⁾ FVMQ may also be counted towards SCFPs; however, it is often compared or listed with FKM/FFKM and was thus included in the class of fluoroelastomers in this report

2. DATA COLLECTION AND ANALYSIS

Data were collected using questionnaires. The data were collected to provide an aggregated overview about the end-products groups manufactured by participating companies of three clusters – water supply, water treatment, gas and liquid fuel components –, typical conditions of application, as well as the components used for manufacturing of end-product groups. With help of these information, a qualitative assessment of potential emission sources during manufacturing, use and end-of-life phase was conducted.

First, information on end-products groups were collected. Data included, e.g., the estimated annual growth, the total estimated concentration of PFAS/FPs, and the typical waste disposal route. For data analysis, end-product groups reported to be manufactured by the participating companies were split into subgroups. **Please note that the list of end-products is non-exhaustive and described subgroups may contain additional similar end-products; however, due to the wide variety of end-products not all can be listed.** Moreover, the list contains all defined end-product groups 1-8, irrespective of the cluster but are included here for consistency with the other cluster reports. Specific information on data gathered are presented in **section 3.1**

Table 2: End-product groups and included product types

End-product group	Type of product included (non-exhaustive list)
1	Faucets, showers
2	Seals, (O-)rings, membranes, sleeves
3	Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids
4	Pipes, piping systems (for showers, sinks, drinking water, drainage)
5	Odorization systems, peripheral systems, blowers, fans
6	Water treatment including water softening systems (membranes clearly specified for use in water treatment systems, ion exchanger, ozone, active bromine, electro-chlorination, chlorine dioxide, chlorine, chemical dosing, UV)
7	Meters, sensors, analysis tools and controls
8	Accessories ¹⁾

¹⁾ Tools were reported by participants, too, but were not included in the assessment.

Second, information on components, of which end-product groups are made of, were gathered. Information queried covered the origin of the component – whether it was purchased as a ready-to-use article or is manufactured by the participating company –, FPs used and the estimated concentration in the component, as well as information on the conditions during use. Similarly to the end-product groups, components which are used for the production above-mentioned end-product groups, have been split into subgroups. Please note that the list of components is non-exhaustive and described subgroups may contain additional similar components. In addition, the list contains all defined component groups 1-8, irrespective of the cluster.

Table 3: Component groups and included component types

Component group	Type of component included (non-exhaustive list)
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats
2	Use as processing aid, contact passivation, etc.
3	Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries
4	Housings, containers, reactors, flame retardant plastic components
5	Paints, adhesives, potting compounds, binders, multi-component compounds, coatings ¹⁾
6	Membranes
7	O-rings, retaining rings, shaft seals, molded seals (gaskets)/(flat) sealings
8	Lubricants (greases, oils), lubricant coatings, bearings/slide bearings

¹⁾ Coating of tools were not included in the assessment as they were considered out of scope

Please note that depending on the position in the supply chain and the product portfolio certain products may be counted towards both end-products and components. This includes e.g. membranes or valves.

In addition, the participants were requested to delineate the standard production process per end-product group. Participants could add any number of steps to outline a process flow for the production. Contextual information was collected per process step; amongst other, information on process type (automatic, manual), place of execution (internal, external), Personal Protective Equipment (PPE) worn by employees, and process temperature were covered.

Questions in the questionnaire did not differentiate between unspecified PFAS as well as FPs. As the main focus of this report are FPs, all data submitted were considered to be provided for FPs. As mentioned in **section 1**, data were included in the assessment if the PFAS compounds was reported to be unknown. In few cases specific information on non-polymeric PFAS or non-PFAS compounds were provided; where identifiable and no relevance to polymeric PFAS was found, these were not included in the assessment. Also, PFAS-containing substances that were indicated as processing aids during galvanic surface treatment were not considered within scope of this report and were excluded from the analysis. Furthermore, the use of PFAS as a coating for tools which are used in the manufacture of products were considered outside of scope of this report.

For a qualitative description of potential FP emissions associated to production, information on the presence of local exhaust ventilation and air cleaning systems, the presence of more general ventilation systems, the generation and amount of wastewater, as well as waste tonnage, estimated FP-concentrations in waste, as well as typical disposal pathways were requested.

Specific information on data analyses is reported as required in the respective place within the document.

3. COMPANIES, PRODUCTS AND COMPONENTS

3.1. Companies & Products

Irrespective of the cluster considered, companies manufacture a wide range of product groups, which consist of several individual components. The participants of this cluster reported to mainly produce ball valves/valves/butterfly valves/regulators/monitors/injectors (end-product group 3) as well as products related to meters/sensors/analysis tools/controls (end-product group 7). An illustrative distribution of end-product groups is depicted in **Figure 1**.

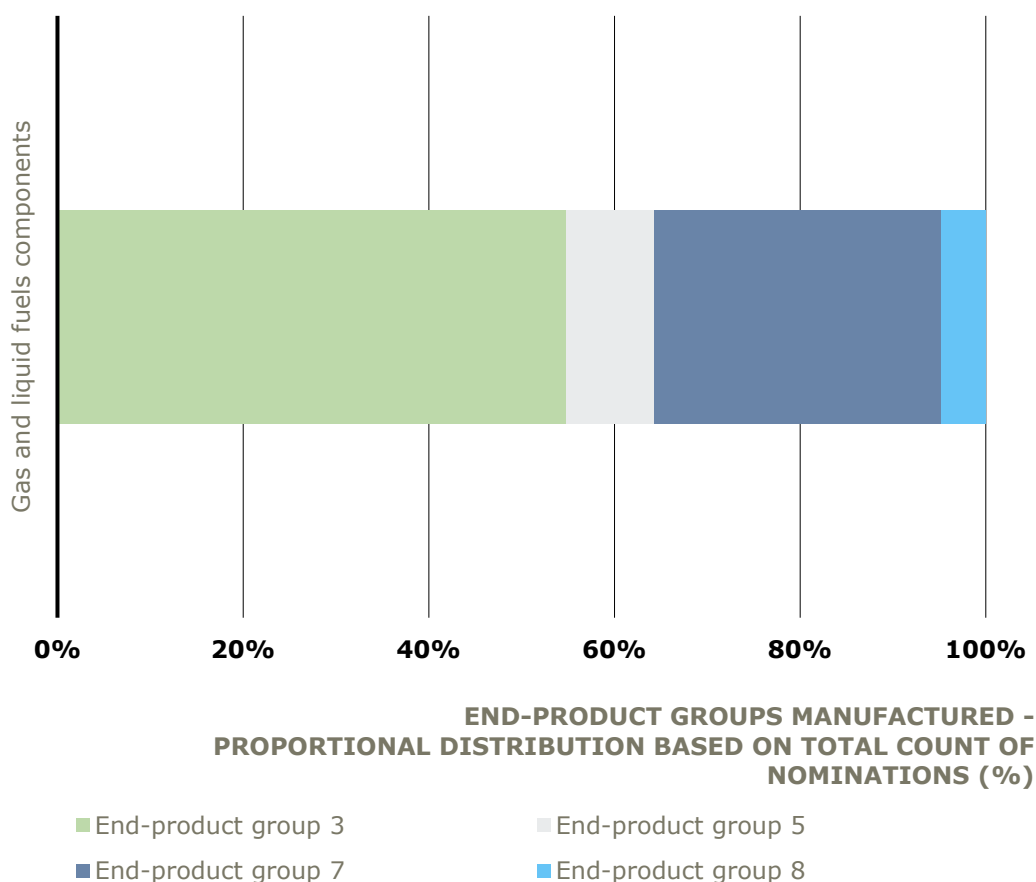


Figure 1: End-product groups manufactured within cluster

Total count of nominations is the number of times an end-product was entered. Each reported entry was allocated to an end-product group. Accordingly, the proportional distribution is based on the total count of entries reported for this cluster; the number of responses were not weighted to account for differing numbers of entries per company. For example, if a company individually reported "faucets" and "showers", $n = 2$ entries were allocated to end-product group 1. If another company individually reported "faucets for bathrooms", "faucets for kitchens" and "showers" $n = 3$ entries were allocated to end-product group 1. The total count of nominations for this end-product group is therefore 5 in this hypothetical example. The proportion puts this number into relation to all entries (products) after allocation to their end-product groups.

Groups are defined as **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for education of gases/liquids; **End-product group 5**: Odorization systems, peripheral systems, blowers, fans; **End-product group 7**: Meters, sensors, analysis tools and controls; **End-product group 8**: Accessories

The proportion (% w/w) of polymeric PFAS (in the following referred to as FP, as this is considered the main scope of this dossier) in end-products groups is summarized in **Table 4**⁷. End-product groups may comprise of a range of individual products of differing composition. Furthermore, the concentration of FPs in components used for the manufacture of end-products is not in all cases known. The presented values should therefore be considered as indicative.

Table 4: Estimated proportion of FPs in end-product groups (% w/w)

End-product group	Average	Median	Minimum	Maximum
End-product group 3	2.4	1.0	0.01	13.5
End-product group 5	1.3	0.06	0.01	5.0
End-product group 7	1.9	0.5	0.01	9.0
End-product group 8	8.2	8.2	2.0	11.3

Acronyms: **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 5**: Odorization systems, peripheral systems, blowers, fans; **End-product group 7**: Meters, sensors, analysis tools and controls; **End-product group 8**: Accessories

A larger difference between mean and median values is observed for end-product group 5 (odorization systems, peripheral systems, and others). Comparison of the mean value (1.3 %) and the median value (0.06 %) suggest that the maximum reported concentration may be an overestimate of actual FP concentrations. Raw data reported can be distributed into two groups: One group ranging from 0.01 to 0.1 % and one of 5.0 %. No concentrations between > 0.1 % and < 5.0 % have been reported. It is however highlighted that the total concentration is in any case still low, with a reported maximum concentration of 5.0 %.

The highest average concentration was identified for end-product group 8 (accessories). The associated components related to this end-product group were – amongst others – listed as O-rings, lubricants and membranes as well as housing components; these components, especially O-rings and membranes, may entirely be made of FPs. Assuming that accessories also cover required spare parts, this provides a possible explanation for the proportionally high FP concentration in this end-product group.

Overall, the FP concentrations are homogeneous, not only within but also between end-product groups. The average concentration is ≤ 2.4 % for three of the four end-product groups, demonstrating that the use of FPs is already limited but required for very specific tasks within the end-products. Accessories (end-product group 8) may contain higher concentrations of FPs, which may be explained by the nature of components reported within this group.

A more detailed overview on components and the related FP material used for the manufacture of products is detailed below (**section 3.2**).

⁷ In the questionnaire, the estimated PFAS concentration in end-products was requested; however, as the scope of this report regards FPs, the wording was adopted in the report.

3.2. Components

Companies covered in this report mainly manufacture end-products via assembly (cf. **section 4.1**); components with and without FP are used to build the end-products described above (**section 3.1**). In this section, components containing FPs are described and their composition, FP concentrations and origin are assessed. To facilitate a comprehensive analysis, components reported were grouped. The grouping is based on assumed functionality of the components (e.g., electronic component, sealing function, or lubricant function).⁸

Table 5 provides an overview on the component groups and the related end-product groups for which they are used. In consistency to the structure of the market – end-products are mostly assembled from various components – several FP-containing components are used per end-product group. Also, the same component group may be used in different end-product groups. For example, (O-)rings and other sealings as well as lubricants or membranes are used in all end-product groups.

Table 5: FP-containing components and use in end-product groups

Component group	Component details	End-product group			
		3	5	7	8
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	+	-	+	-
2	Use as processing aid, contact passivation, etc.	+	-	-	-
3	Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries	+	+	+	+
4	Housings, containers, reactors, flame retardant plastic components	+	-	+	+
5	Paints, adhesives, potting compounds, binders, multi-component compounds, coatings	+	+	+	+
6	Membranes	+	+	+	+
7	O-rings, retaining rings, shaft seals, molded seals (gaskets)/(flat) sealings	+	+	+	+
8	Lubricants (greases, oils), lubricant coatings, bearings/slide bearings	+	+	+	+

Acronyms: +: Components used for the manufacture of this end-product group; -: Components not used for the manufacture of this end-product group; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 5**: Odorization systems, peripheral systems, blowers, fans; **End-product group 7**: Meters, sensors, analysis tools and controls; **End-product group 8**: Accessories

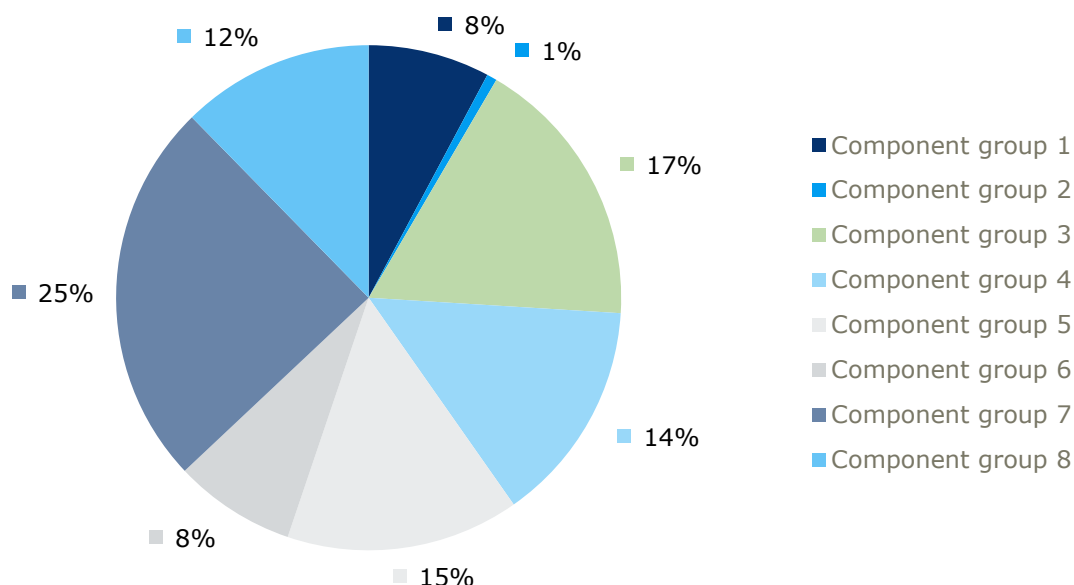
⁸ Please note that FP-containing substances that were indicated as processing aids during galvanic surface treatment were not considered within scope of this report and were excluded from the analysis. Furthermore, the use of FP as a coating for tools which are used in the manufacture of products were considered outside of scope of this report.

With regard to the origin of the components, three categories were defined:

- Category 1 – Obtained as PFAS raw material (substance) e.g., VDF for polymerization of PVDF; PFAS for dissolution in solvents) [not relevant for this cluster – gas & liquid fuels]
- Category 2 – Obtained as FP raw material (mixture/intermediate) e.g., PVDF for own manufacturing of membranes; different kinds of oils/solutions for own mixing processes [not relevant for this cluster – gas & liquid fuels]
- Category 3 – Obtained as ready-to-use article e.g., industrially-manufactured O-ring; purchased, unchanged solution/oil

Underlining the importance that the figawa members are mainly assembling their end-products, all of the components are obtained from third-party suppliers. These components are used directly without further processing. 100 % of all reported components used in this cluster fall into category 3. Neither FP nor non-FP PFAS raw materials were reportedly used e.g., for membranes made from PVDF/use of oils (category 2), or for solutions for own mixing processes for the own polymerization of FP, or for the dissolution in solvents (category 1). Please note that it cannot be derived from the data, however, to which proportion the individual component groups contribute to the final end-products or to the companies' sales. For an in-depth analysis of sales and revenue dependency of FP-related products, please refer to the SEA document submitted along this CSR.

The largest component groups in category 3 are groups 3 (17 %) and 7 (25 %). In agreement with previous market description, industrially bought sealings including O-rings (component group 7) are mentioned most often. Please note again that this proportion does not allow inferences to volumes of the component used. It indicates nonetheless the dependency of companies on very basic working components which they may not produce themselves and on the substitution of which they have very limited influence. The distribution of component groups in category 3 is visualized in **Figure 2**.

CATEGORY 3 - COMPONENT OBTAINED READY-TO-USE**Figure 2: Components' origin in relation to the components sub-group**

Acronyms: Groups are defined as **Component group 1**: Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats; **Component group 2**: Use as processing aid, contact passivation, etc.; **Component group 3**: Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries; **Component group 4**: Housings, containers, reactors, flame retardant plastic components; **Component group 5**: Paints, adhesives, potting compounds, binders, multi-component compounds, coatings; **Component group 6**: Membranes; **Component group 7**: O-rings, retaining rings, shaft seals, molded seals (gaskets)/(flat) sealings; **Component group 8**: Lubricants (greases, oils), lubricant coatings, bearings/slide bearings

The composition of the components used is oftentimes not exactly known to the purchasers and might be subject to confidential business information. The estimated concentration of FP in components is presented in **Table 6**⁹. It is acknowledged that the FP concentration differs distinctly from the total concentration estimated for the end-products (cf. **Table 4**). The end-products may consist though of non-FP and FP-containing materials. As discussed in **section 3.1**, the total concentration of FPs in most end-products groups is low, and three of four end-product groups showed concentrations below ≤ 2.4 %. The data indicate therefore that even at high concentrations of FP in most component groups, the impact on the final concentration in end-products is limited.

Table 6: Average, estimated total FP concentrations (%) in components

Component group	Components	Average concentration of FP (%)
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	57.0
2	Use as processing aid, contact passivation, etc.	100.0
3	Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries	4.6
4	Housings, containers, reactors, flame retardant plastic components	21.7
5	Paints, adhesives, potting compounds, binders, multi-component compounds, coatings	32.8
6	Membranes	72.9
7	O-rings, retaining rings, (flat) sealings	55.9
8	Lubricants (greases, oils), lubricant coatings, bearings/slide bearings	11.4

¹⁾ Please note that not all components were necessarily reported in this cluster.

It is important to note that estimated FP-concentrations in components are based on the expert knowledge of participating companies but not necessarily on information from the suppliers of the component. This is similarly true regarding the individual FPs used in the components. Individual FPs identified in components are listed in **Table 7** below.

⁹ In the questionnaire, the estimated PFAS concentration in components was requested; however, based on the first submission of figawa (please see comment 4433 from 2023-06-02 accessible via <https://echa.europa.eu/documents/10162/8d917581-7faf-4e1a-26d4-073d52b3406e> (last accessed 2023-09-15)), the scope of the requested derogation and the exceptional importance of FPs for figawa members, as the scope of this report regards FPs, the wording was adopted in the report and focused on FP

Table 7: FPs substances reported in components

Component group	PTFE	FEP	PVDF	FKM	FVMQ	PFPE
1	+	-	-	+	-	-
2	-	-	-	-	-	+
3	+	+	+	+	-	-
4	+	-	+	+	-	-
5	+	-	-	+	-	-
6	+	-	+	+	+	-
7	+	-	-	+	-	-
8	+	-	-	+	-	+

Groups are defined as **Component group 1**: Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats; **Component group 2**: Use as processing aid, contact passivation, etc.; **Component group 3**: Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries, **Component group 4**: Housings, containers, reactors, flame retardant plastic components; **Component group 5**: Paints, adhesives, potting compounds, binders, multi-component compounds, coatings **Component group 6**: Membranes; **Component group 7**: O-rings, retaining rings, shaft seals, molded seals (gaskets)/(flat) sealings; **Component group 8**: Lubricants (greases, oils), lubricant coatings, bearings/slide bearings

The exact composition of the components used is in many cases unknown, since this information is considered confidential business information by many suppliers or manufacturers. As such, the information prepared by the figawa members may be incomplete, and for certain components no information could be provided. Once again, this illustrates the difficult situation which companies of this market face. As the companies of this dossier are a small part within the supply chain of FP-containing materials it is not only inherently difficult to collect such information, but also even more challenging to provide adequate alternatives to ensure the quality, longevity and safety of their products.

4. LIFE CYCLE STAGES AND CONSIDERATIONS ON EMISSIONS

4.1. Manufacturing

Based on the data gathered for the manufacturing, the assembly was identified as the main task. It is mainly conducted manually, internally and at room temperature. No specific PPE is required for employees. Due to the low potential for generation of fumes or dusts, no Local Exhaust Ventilation (LEV) system is installed at assembly workstations. However, general hall/room ventilation systems are in place for air renewal/conditioning. The generation of wastewater was not reported.

Waste is disposed with other process waste, which is then considered to be disposed of as residual waste under standard conditions; the major proportion of such waste is assumed to be incinerated (including waste-to-energy recovery), while smaller proportions may end up in landfills. The estimated annual waste tonnage related to this process step was identified as 5.40 tons; the concentration of FP in waste is estimated to be 2.51 %. For further information on waste-treatment options please refer to **section 4.3**. A summary of the data for the assembly step is provided in **Table 8**.

Table 8: Process description – Assembly

Process parameters	Selection ¹⁾
Process type	Manually, automatically, or Both manual and automatic steps
Task is performed	Internally
PPE	Standard work clothes (shirt/long-sleeve, long trousers, safety shoes/boots) or Standard work clothes, gloves (chemicals)
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	Other
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m ³]	—
Waste tonnage [tons]	5.40
Proportion of FP in waste [%]	2.51
Waste disposal route	Collected and disposed with other process waste

¹⁾ See **Annex I** for a list of selection options

In addition to the assembly, the tasks of “other/additional steps” are highlighted (**Table 9**). These were, for example, manufacturing of housings/metering-devices or coating of devices during sheet steel production involving heating steps.

Table 9: Process description – Other/additional step

Process parameters	Selection ¹⁾
Process type	Automatically
Task is performed	Internally
PPE	Standard work clothes (shirt/long-sleeve, long trousers, safety shoes/boots) or Standard work clothes, overall/coat, gloves (chemicals), RPE
Process temperature	15 - 25 °C (room temperature) or > 150 °C
LEV	Partially available
Filter systems after LEV	Other
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	Partially possible
Wastewater volume [m ³]	19.00
Waste tonnage [tons]	0.01
Proportion of FP in waste [%]	0.97
Waste disposal route	Collected and disposed with other process waste

¹⁾ See **Annex I** for a list of selection options

For the tasks of “other/additional step” the process temperature was either reported as 15 – 25 °C or > 150 °C. As these processes might involve heating, the potential for exposure is increased compared to other tasks, such as assembly. Please note that before heat-treatment, the products are coated with (potentially) PFAS-containing raw material. Excess powder is collected and re-used. The process includes a LEV system with subsequent filtering of exhaust air. Heat-treated steel sheets are cooled with water, which is emitted to the municipal wastewater treatment system. Please note no derogation is requested for this raw material; it is thus only mentioned to provide a complete description of the process flow. This process has to be adjusted in context of the PFAS restriction.

With regard to FPs, it is outlined in a processing guide by PlasticsEurope (2021) that typical processing temperatures, e.g., of PTFE or PVDF, are 380 °C and 230°C, respectively. Especially from an occupational safety perspective, it is noted in the document that the generation of fumes from FP decomposition may occur even at processing temperatures. Importantly, it is additionally stated that “significant decomposition occurs only above the recommended continuous service temperature for the polymer in question” (PlasticsEurope, 2021).

Workplace exposure and emissions can be controlled by LEV. Accordingly, the availability of LEV was partly reported for these process steps. Furthermore, to control emissions, additional filter systems associated to the LEV were reported. General hall ventilation systems or heating, ventilation, air conditioning (HVAC) systems were also reported for 100 % of “other/additional steps”.

Wastewater may be generated partially, with a reported average annual wastewater volume of 19.00 m³. This wastewater is assumed to be related to cooling processes in case of “other/additional steps”. As no measurement data are available, a more detailed analysis regarding substances and quantities of wastewater emissions cannot be performed. However, in relation to these tasks, it was stated that wastewater is filtered and treated in municipal wastewater treatment plants (WWTP). Overall, the potential for

emissions of FPs via wastewater of this process cannot be excluded but is considered limited. As mentioned for emissions to air, emissions to wastewater generated during these process steps are most likely also related to the use of non-polymeric PFAS, for which no derogation is requested as part of this report.

The waste tonnage and FP concentration therein were estimated to be 0.01 tons and 0.97 %, respectively. Similar as described above, waste is disposed with other process waste.

During manufacture, emissions may potentially occur via exhaust air, especially during heating steps and such steps with LEV systems for exposure control, and via wastewater. No measurements are available to estimate potential emissions from these steps. It is highlighted though that the primary way of operating is the assembly of components to end-products, from which no emissions are expected. Moreover, a significant degradation of FP material takes only place above recommended process temperatures (PlasticsEurope, 2021). The performance of further steps which might bear an increased emission potential compared to the assembly is very limited. Other tasks, such as delivery and storage or post-treatment and quality control are considered to have a comparably low potential for emissions. Process descriptions of these tasks are outlined in **Annex I**.

Despite the very low potential for emissions during manufacturing processes of end-product groups, figawa-members are open towards the implementation of regular monitoring programs – provided that guidance on the target substance analysis exists, or sensitive and appropriate untargeted (e.g., Total Organic Fluorine) measurements methods become widely available. figawa-members are also supportive of repetitive evaluation programs and the potential improvement of implemented risk management measures.

4.2. Use phase

Components may be exposed individually to different conditions during their intended use. For example, membranes build into an end-product would most likely not be exposed to the same conditions as electronic compartments.

FPs have remarkable properties and are chemically stable (Korzeniowski *et al.*, 2023). As an example, little effect is expected on PVDF by acid exposure, because PVDF is considered to be stable in acidic environments (Marshall *et al.*, 2021). The authors further elaborate that in strong alkaline conditions ($\text{pH} \geq 11$) PVDF may undergo de-hydrofluorination. However, based on market experience and longevity of products, degradation due to chemical exposure of PVDF has not been recognized as an issue of concern as uses at $\text{pH} \geq 11$ are rare. In addition, it has to be attributed to the companies that expert knowledge on the applicability of their products – not only containing PVDF – but also other FP-based components – is extensive. Based on the market experience and customer satisfaction no significant degradation has been described under standard operation conditions.

The pH range to which components are exposed during their use are outlined in **Table 10**. Most components are in contact with media having a neutral pH. No applications are expected exclusively in the basic or the complete pH range.

Table 10: pH ranges to which components are exposed during use

Component group	Components	pH conditions under which parts are operated			
		Acidic	Neutral	Alkaline	Whole pH scale
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	+	+	-	-
2	Use as processing aid, contact passivation, etc ¹⁾	-	-	-	-
3	Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries	-	+	-	-
4	Housings, containers, reactors, flame retardant plastic components	-	+	-	-
5	Paints, adhesives, potting compounds, multi-component compounds, coatings	-	+	-	-
6	Membranes	+	-	-	-
7	O-rings, retaining rings, shaft seals, molded seals, (flat) sealings	-	+	-	-
8	Lubricants (greases, oils), lubricant coatings, bearings/slide bearings	-	+	-	-

¹⁾ Component group 2 has been reported individually, but no data on pH of contact media was provided.

It cannot be excluded that wear- and tear-effects may contribute to emissions of FPs. For example, O-rings or sealings may be exposed to friction or pressure during use. While no quantitative data is available, it is important to note that the service-life of products is long and a high durability is required for correct and safe functionality. The extent of wear- and tear-effects is thus considered limited. Furthermore – specifically for this cluster – no components were exclusively reported to come into contact with water, which is used as

drinking water or emitted to wastewater and has a higher potential for release into the environment. The data suggest that air/gases are the main contact media. In this regard, it is expected that wear- and tear-effects will not contribute to environmental emissions if industrial solutions or air/gases are processed by end-products. An overview on typical contact media of components is provided in **Figure 3**.

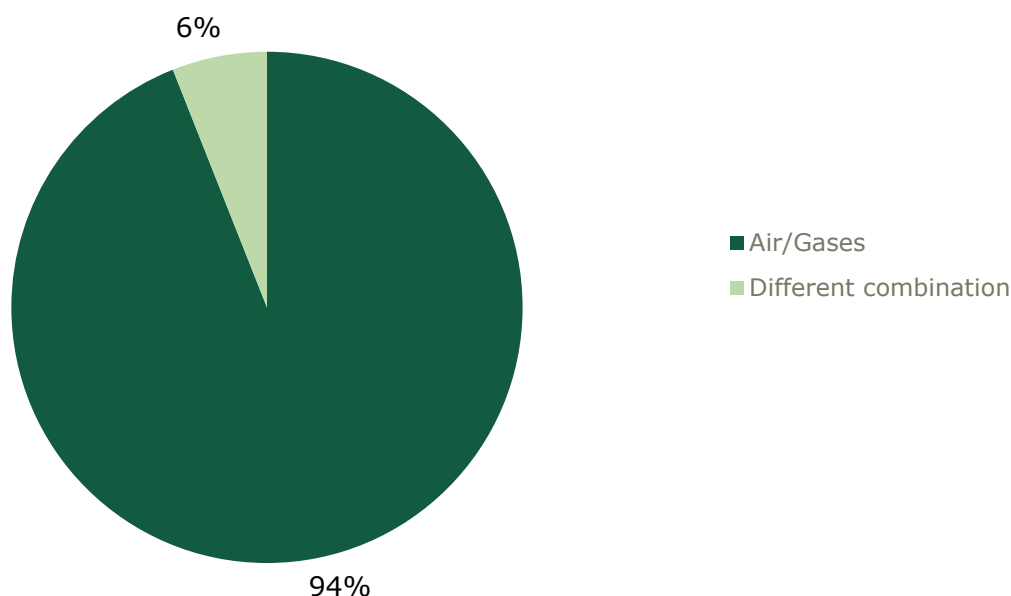


Figure 3: Overview on contact media of components during use

Participants were able to choose from different options and combinations of options:

Option 1: (Waste-)Water; **Option 2:** Drinking water; **Option 3:** Liquid fuels (e.g. oil/heating oil/HVO); **Option 4:** Other solutions (incl acids and bases)/solvents; **Option 5:** Air/Gases; **Option 6:** (Waste-)Water & Drinking water; **Option 7:** Liquid fuels (e.g. oil/heating oil/HVO) & other solutions (incl acids and bases)/solvents; **Option 8:** All mentioned; **Option 9:** Different combination (this option is not only considered to include a different combination of mentioned options but also those not named, such as e.g., swimming pool water, industrial water of different constitution, etc.)

Emissions during the use phase may also be of special importance for component groups 1, 2, 5 and 8¹⁰. Especially for the case of lubricants, FP-containing components may under certain circumstances be rinsed out during intended use. Lubricants may be used in components like valves or already applied as coatings to sealings, which are oftentimes bought as components from third-party suppliers. An assessment of the exact composition and amount of lubricants used is – as mentioned previously – not possible, and these parts have not been considered here. It needs to be specified however, that this is only relevant for components in direct contact with water or other liquids. No potential for wash-off is considered for contact media such as gas or air. For this cluster, it is therefore assumed that the releases from use of lubricants can be disregarded.

In summary, the emission potential of FPs from most of the components described is considered very low. This is mainly based on the fact that FPs are thermally and chemically inert. Moreover, the majority of components were reported to not be direct contact to

¹⁰ **Component group 1:** Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats; **Component group 2:** Use as processing aid, contact passivation, etc; **Component group 5:** Paints, adhesives, potting compounds, binders, multi-component compounds, coatings; **Component group 8:** Lubricants (greases, oils), lubricant coatings, bearings/slide bearings

media – such as water or wastewater – which facilitate an entry of FPs into the environment. This is similarly true for both wear- and tear as well as the use of lubricants. In any case, considering the long service-life and required durability of products, the potential for emissions is limited.

4.3. End-of-life stage

The area of application for products manufactured by figawa members is of high public interest. They help to ensure the safe supply of heat via gas and liquid fuels not only for industrial applications but also for private households. As such a high quality and durability is required, which is also achieved by the use FP-containing materials due to their distinct physicochemical properties and low hazard profile. The resulting service life of end-products is long, reducing expensive replacement of products and therefore also reducing the amount of waste generated (see **Figure 4**).

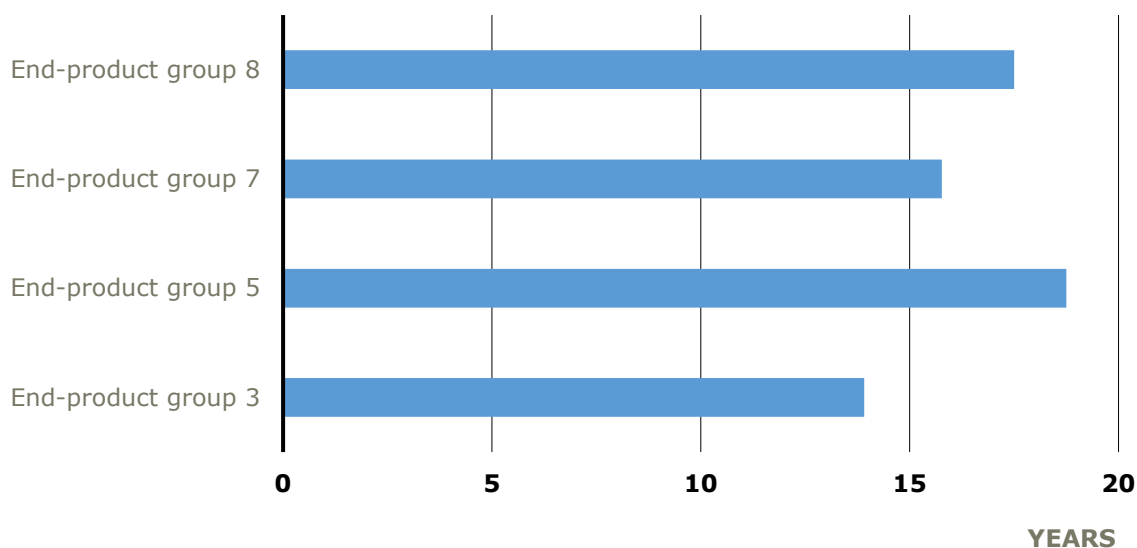


Figure 4: Average service-life duration of end-product groups

Groups are defined as **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 5**: Odorization systems, peripheral systems, blowers, fans; **End-product group 7**: Meters, sensors, analysis tools and controls; **End-product group 8**: Accessories, tools

It was also queried which proportions of waste – according to the participants market knowledge – are incinerated (including waste-to-energy), landfilled or recycled.¹¹ The assumed disposal route dependent strongly on the end-product group or its built-in components. Most of the end-products are reported to be recycled at the end of their service life (see **Figure 5**). Similarly, electronic components are to a large fraction disposed according to electronic-waste regulations. The data are subject to uncertainty, however, as the disposal of end-products is in most cases of out scope of the manufacturers.

¹¹ For the analysis of the responses the average was calculated for each section and sub-group of end-product separately. However, as not in all cases the sum of all three disposal routes equaled 100 % (e.g., 10 % incineration, 10 % landfill, 55 % recycling), the calculated averages were subsequently normalized to 100 % (i.e. 13.3 % incineration, 13.3 % landfilling, 73.3% recycling).

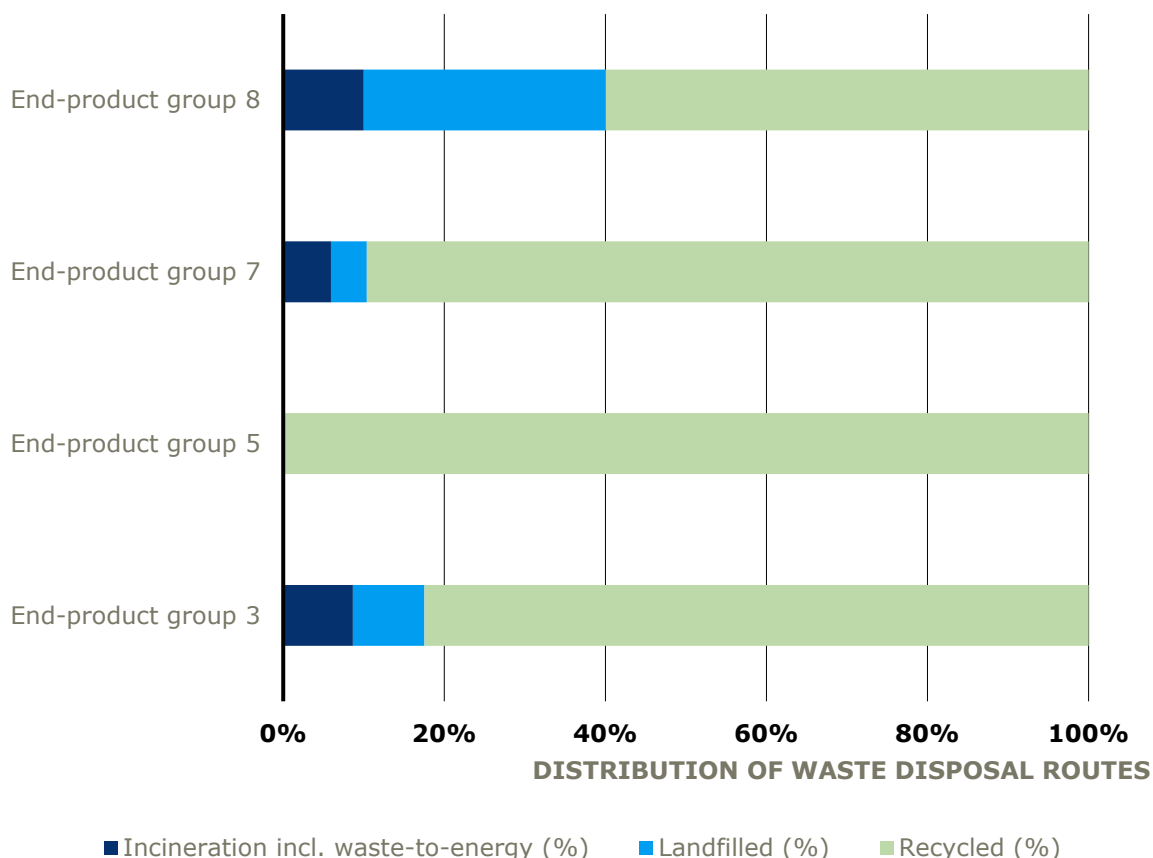


Figure 5: Assumed disposal routes of end-products

Groups are defined as **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for education of gases/liquids; **End-product group 5**: Odorization systems, peripheral systems, blowers, fans; **End-product group 7**: Meters, sensors, analysis tools and controls; **End-product group 8**: Accessories, tools

Potential emissions from waste disposal are difficult to standardize as they depend not only on the proportion of PFAS in the component but also on the specific PFAS within the product, the associated formation of by-products e.g., from incineration, or whether an end-product is dismantled before final disposal. As presented in **Table 4**, the overall concentration of FPs is low in most end-products (≤ 2.41 %). Fewer end-product groups may have FP concentrations of up to 8.15 %.

Regarding landfilling, Lohmann et al. (2020) report that FP landfilling leads to contamination of leachates with PFAS. On the other hand, it has been summarized by Korzeniowski et al. (2023) that FPs "[...] such as PTFE do not degrade in the environment or release substances of toxicological or environmental concern" due to the stability of FPs. With regard to landfilling, the authors further conclude that – because of the chemical, thermal and biological properties – FPs "[...] therefore are not expected to transform to dispersive nonpolymeric PFAS when disposed of in a landfill". No information has been provided specifically for FPs in Annex B to the ECHA restriction proposal (2023a). It is not clear whether landfilled FPs cause emissions to the environment via landfill leachates. While not specifically related to landfill conditions, a summary of a set of studies on leaching and (bio)degradation of PTFE published by Gore (2022) concludes that the stability of PTFE is supported and no partitioning to air, water or soil is expected.

Recycling is most likely related to metals or other valuable raw materials used in end-products, for which relevant recycling approaches exist. The components are often part of appliances that are replaced at the end of their lifetime by craftsmen with dedicated processes for their scrap metal and scrap electronics. FP recycling from post-consumer waste is however difficult; as outlined in a report by Conversio (2022) this is because for FPs the overall share "[...] is too low to establish any sorting and recycling approach" in mixed waste streams. Despite the current difficulties regarding recycling, figawa members would like to highlight that FPs are important and valuable materials. Recycling is also an effective measure to reduce the amount of waste entering other waste-streams. The development of a regulatory framework for the recycling of FP materials should thus be emphasized. figawa members are in support of the development of legal requirements leading to the implementation of a recycling system for FPs.

Even though partly high landfilling and recycling rates were reported for specific end-product groups, the main route of waste disposal in Europe is considered incineration. Incineration may either take place in municipal incinerators with or without waste-to-energy recovery or in hazardous waste incinerators. Latter one's are usually operating at higher furnace temperatures. Complete, uncatalyzed, destruction of PFAS is expected at temperatures $> 1,400\text{ }^{\circ}\text{C}$ (ECHA *et al.*, 2023a), which is not typically achieved by municipal incinerators.

Korzeniowski *et al.* (2023) point out in a review that FPs are mineralized during commercial waste-to-energy incineration. For example, Aleksandrov *et al.* (2019), which are also cited by Korzeniowski *et al.* (2023), report for the incineration of PTFE that hydrofluoric acid (HF) is the main decomposition product. In a report by RIVM from Bakker *et al.* ((2021)), which is cited by Korzeniowski *et al.* (2023), it is summarized that FPs including PTFE are "one of the most thermally stable plastics" but for PTFE "complete thermal decomposition is achieved at a temperature of about $800\text{ }^{\circ}\text{C}$ ". However, the formation of by-products is described possible during incineration (Bakker, Bokkers and Broekman, 2021). The authors conclude though that "based on a literature review, RIVM expects that most of the PFASs will largely degrade during the incineration process and then be removed when the flue gases are cleaned". Silva *et al.* (2020) similarly report the formation of HF for thermal degradation of PVDF, but also of other by-products. Annex B to the ECHA restriction proposal (2023a) summarizes literature sources and concludes that thermal degradation products from FP degradation may not only contain CO_2 or HF, but also trifluoroacetic acid and other perfluorinated gases, and further substances. It is therefore acknowledged that incineration of FP-containing end-product groups may lead to the formation of fluorinated by-products via thermal degradation. The ratio of main- (HF) to by-product formation is however unclear.

Regarding SCFPs, it is acknowledged that they were counted towards PFAA precursors for the impact assessment presented in the restriction proposal (ECHA *et al.*, 2023b, 2023a). A higher reactivity is expected and degradation into other PFAS is expected (ECHA *et al.*, 2023a). However, it should be stressed that SCFPs in form of fluorinated acrylate polymers were only mentioned individually for electronic compartments with air/gases as the respective contact media in the dataset of the cluster "water supply". Electronic compartments are already subject to separate waste regulations, and it can be assumed that both the use and end-of-life phase are strictly controlled.

From market knowledge and previous comments submitted to ECHA with regard to the restriction proposal¹² (state: 25th of August, 2023) it is understood that more detailed information on incineration of PFAS has been provided, and studies on incineration are being conducted. It is also expected that – induced by the ECHA restriction proposal (2023b) – necessary research on waste treatment options is enabled even further. It is therefore assumed that knowledge on by-product formation as well as progress on (new) abatement technologies will be made available in quick succession, not only for solid wastes but also for wastewater (Verma *et al.*, 2023). On this basis, regulatory threshold values, e.g., on exhaust air emission from waste incinerators or from wastewater treatment plants could be implemented. As the necessity and potential to examine and subsequently minimize emissions from waste treatment of FPs is seen, this approach is supported by figawa members.

¹² <https://echa.europa.eu/de/registry-of-restriction-intentions/-/dislist/details/0b0236e18663449b>

5. SUMMARY & CONCLUSIONS

figawa members require FPs for the safe and durable operation of their products. It has been shown that members purchase most components on the open market. In addition, figawa members are only involved to a limited extent in the design of the components used as the main task conducted at their sites is the assembly of end-products. As such, emissions from the manufacturing phase of products are considered to be controlled and negligible.

During the intended use of end-products, emissions are likewise considered to be controlled as FPs are chemically and thermally stable as well as durable. Emissions may arise from wear- and tear of specific components, which are exposed to extensive mechanical pressure (e.g., sealings or membranes). As products are very durable, and market knowledge and customer feedback did not lead to an increased concern of end-product wear- and tear, no quantification is possible. Potential emissions from wear- and tear may thus be subject to further research, and figawa members are supportive of such regulatory measures if proposed by authorities. Emissions may be caused by the use of lubricants, especially if in contact with wastewater or drinking water; this is considered not relevant for this cluster as the main contact media were identified as air/gases. Overall, potential emissions are estimated to be small in comparison to emissions of other sectors and uses.

For the end-of-life phase, data regarding emissions from waste treatment are scarce. It is acknowledged that during incineration the generation of by-products may occur. Incineration is nonetheless considered a valid treatment option as complete degradation of FPs is possible. It is assumed that new information regarding waste treatment will be published in near future, driven by the restriction proposal by ECHA. A solidified understanding of the emission potential may correlate in an improvement of abatement technologies, if required. While regulation of emissions is endorsed by figawa and their members, it is emphasized that more data are required for an appropriate regulatory approach.

It is in this respect noted that manufacturers of FPs are already reacting to reduce emissions. In relation to emissions counted towards the life-cycle of FPs, Lohmann et al. (2020) identified the use of polymerization aids as a large concern. However, Solvay – a large producer of FPs and PFPEs – recently announced the goal to phase out the use of fluorosurfactants for the production of FPs (Solvay, 2023). Similarly, Gujarat Fluorochemicals (GFL) announced the development of a non-fluorinated polymerization aid for the manufacturing of PTFE via emulsion polymerization (Gujarat Fluorochemicals, 2022).

In summary, figawa members produces key products for the safe supply and treatment of water as well as for heating and cooling systems. The overall concentration of FPs in such products is low. The figawa members mainly rely on continued supply of products within the supply chain. The exposure potential during their own manufacturing processes as well as the use-phase and disposal of their products is low. Limited emissions may not be excluded due to wear- and tear as well as from waste treatment such as incineration. It is however emphasized that the largest proportion of processes, components and end-products are not prone to emissions. Instead, research is required for a better

understanding of the extent of these potential emissions. On that basis, regulation may be applied more targeted, including limit values for irreplaceable uses.

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Annex

I. PROCESS DESCRIPTION – SELECTION OPTIONS IN QUESTIONNAIRE

Process type	Manually Automatically Both manual and automatic steps
Task is performed	Internally Externally
PPE ¹⁾	Standard work clothes (shirt/long-sleeve, long trousers, safety shoes/boots) Standard work clothes, gloves (chemicals) Standard work clothes, gloves (chemicals) + RPE 1) Standard work clothes, overall/coat Standard work clothes, overall/coat, gloves (chemicals) Standard work clothes, overall/coat, gloves (chemicals), RPE 1) Other
Process temperature	< 15 °C 15 - 25 °C (room temperature) 25 - 50 °C 50 - 150 °C > 150 °C
LEV	Yes No
Filter systems after LEV	No filter system after extraction One-step membrane filter to reduce particles Multi-step membrane filter to reduce particles Multi-step membrane filter to reduce particles + additional filter steps Wet scrubber Wet scrubber + additional filter steps Other
Hall ventilation (e.g., HVAC)	Yes No
Generation of wastewater	Yes No
Wastewater volume [m ³]	####
Waste tonnage [tons]	####
Proportion of FP in waste [%]	####
Waste disposal route	Collected and disposed with other process waste Separate collection and disposal

¹⁾ Please note that safety goggles were not specifically part of the selection options but are considered to be included in the set of standard work clothes.

II. ADDITIONAL TASKS REPORTED

Table 11: Process description – Delivery and storage

Process parameters	Selection ¹⁾
Process type	Automatically
Task is performed	Internally
PPE	Standard work clothes (shirt/long-sleeve, long trousers, safety shoes/boots) or Standard work clothes, gloves (chemicals)
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	Other
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m ³]	—
Waste tonnage [tons]	0.05
Proportion of FP in waste [%]	5.00
Waste disposal route	Collected and disposed with other process waste

¹⁾ See **Annex I** for a list of selection options

Table 12: Process description – Post-treatment/Quality control

Process parameters	Selection ¹⁾
Process type	Automatically or Both manual and automatic steps
Task is performed	Internally
PPE	Standard work clothes, gloves (chemicals)
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	Other
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m ³]	—
Waste tonnage [tons]	11.73
Proportion of FP in waste [%]	2.50
Waste disposal route	Collected and disposed with other process waste

¹⁾ See **Annex I** for a list of selection options