CHEMICAL SAFETY REPORT

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

Submitted by figawa e.V.

Date 22.09.2023

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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, Chlorotrifluorethylene, hexafluoroisobutylene terpolymer; Polytetrafluoroethylene-cohexafluoropropylene
FKM/FFKM	*Fluorkautschuk* / Fluorine rubber / Fluorocarbon-based fluoroelastomer
FPs	Fluorpolymers
FVMQ	Fluorosilicone
HVAC	Heating, ventilation, air conditioning
LEV	Local Exhaust Ventilation
PFA	Perfluoroalkoxy polymer
PFAS	Per- and polyfluoroalkyl substances
PFPEs	Perfluorpolyethers
PLC	Poylmers of low concern
PPE	Personal Protective Equipment
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene fluoride
PVDF-HFP	Vinylidene fluoride, hexafluoropropene copolymer
SCFPs	Side-chain fluorinated poylmers
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 AISBL[3]. 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 material[4]. 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 proposed[5]. 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 manufacturers as thermally and chemically stable with good dielectric properties, depending on the product[6]. 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)

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, chlorotrifluorethylene, 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 (Flurocarbon)	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 water treatment including softening systems (end-product group 6) as well as valves/regulators/monitors/injectors (end-product group 3). An illustrative distribution of end-product groups is depicted in **Figure 1**.

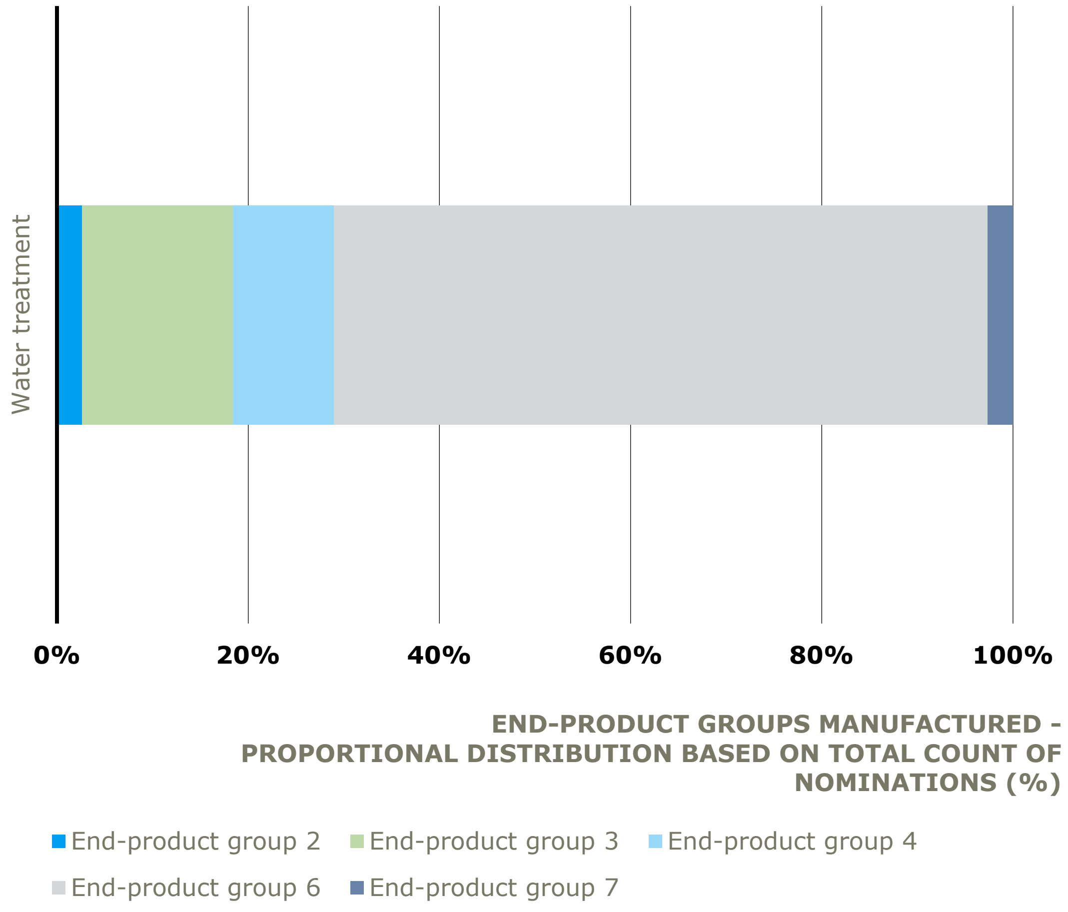

Figure 1: End-product groups manufactured within cluster

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 2**: Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 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); **End-product group 7**: Meters, sensors, analysis tools and controls

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 2	100.0	100.0	–	100.0
End-product group 3	5.3	6.0	2.0	8.0
End-product group 4	68.8	90.0	0.02	95.0
End-product group 6	6.0	1.0	0.0004	100.0 [1)]
End-product group 7	0.5	0.5	–	0.5

Acronyms: **End-product group 2**: Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 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); **End-product group 7**: Meters, sensors, analysis tools and controls
[1)] Reported as ultrafiltration membranes

As expected, end-product group 6 (water treatment including softening systems) was identified as the main group of this cluster. While a low FP concentration was reported on average (6.0 %), a larger difference between mean and median values was observed. Comparison of the mean value and the median value (1.0 %) suggest that the maximum reported concentration (100.0 %) refers to individual applications (here: ultrafiltration membranes) which have been considered as end-products rather than components, and are entirely made from FP. It is also supplemented by the reported data that water treatment and softening systems mainly contain limited amounts of FPs; the concentrations reported can be distributed into three groups: One group of 0.0004 %, one group ranging from 0.1 to 6.0 % and one group of 100.0 %. No concentrations between > 6.0 and < 100.0 % have been reported. Consistently, comparably high concentrations were for example reported for membrane technologies.

In an individual case, membranes were also reported along gaskets, which were accordingly counted towards end-product group 2. Articles from this end-product group thus may completely consist of FPs. They may be used as components for the production of further products, or the FP material used provides the characteristics required for the product's area of application (e.g., in case of membranes). Note that products of end-product group 6 can similarly contain components being end-products of other manufacturers falling in end-product groups 2, 3, 4, or 7.

Likewise, a high maximum FP concentration (95.0 %) was observed for end-product group 4 (pipes/piping systems). However, the data suggest that this end-product group is either made completely from FP materials or contains small residues only (0.02 % to 95.0 %). When comparing the average concentration (68.8 %) and the median value (90.0 %), it is indicated that the distribution is skewed to higher concentrations. Raw data

[7] In the questionnaire, the estimated PFAS concentration in components was requested; however, as the scope of this report regards FPs, the wording was adopted in the report.

reported can be distributed into two groups: One group of 0.02 % and one ranging from 90.0 to 95.0 %. No concentrations between > 0.02 and < 90.0 % have been reported.

Overall, the FP concentrations are homogeneous, not only within but also between end-product groups. The average concentration is ≤ 6.0 % for three of the five end-product groups, demonstrating that the use of FPs is already limited but required for very specific tasks within the end-products. For end-product groups 2, FPs were individually listed as the main constituent; this group includes membranes and gaskets. These are considered to be either processed further or used directly, for example as membranes. Pipes and piping systems (end-product group 4), may be counted to both high and low concentration groups, which is sensible considering their intended use.

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

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 electronic components, or lubricants are used in most end-product groups.

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

Component group	Component details	End-product group				
		2	3	4	6	7
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	-	+	+	+	-
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 2: Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 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); **End-product group 7**: Meters, sensors, analysis tools and controls

[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 – water treatment]
- 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
- 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, the largest proportion of the components are obtained from third-party suppliers. These components are used directly without further processing. 90 % of all reported components used in this cluster fall into category 3. The remaining 10 % are manufactured from FP raw material (e.g., membranes made from PVDF/use of oils or solutions for own mixing processes), falling under category 2. No non-FP PFAS raw materials were reportedly used e.g., 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.

Category 2 is dominated by component group 1 (spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats). Companies predominantly mentioned membranes as well as pipes and fittings for which FP raw material was used.

The larger category 3 is dominated by component groups 1 (36 %) and 7 (26 %). It is in agreement with previous market description, that components of these two groups such as valves, hoses, spacers and others, as well as sealings including O-rings, respectively, 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. Due to the importance of this category, only the distribution of component groups in category 3 is visualized in **Figure 2**.

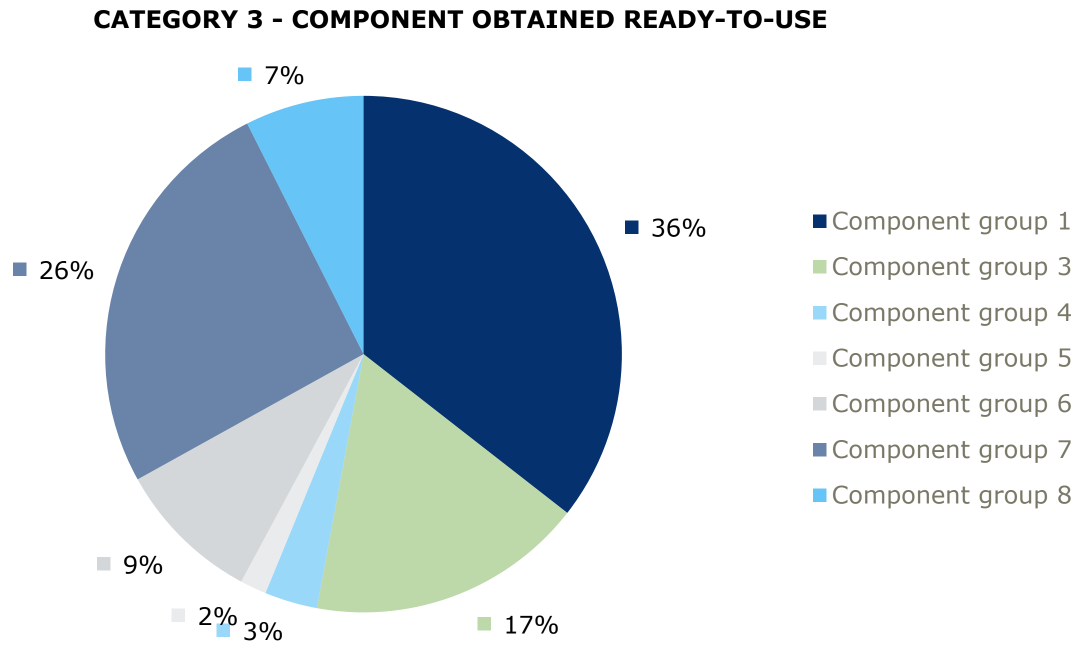

Figure 2: Components' origin in relation to the components sub-group

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 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 of non-FP and FP-containing materials. For specific end-products, e.g. pipes/piping systems, the FP concentrations may be higher as they consist of individual or few components only. This is also reflected by the high average concentration of 87.1 % for component group 1, which includes pipes and fittings. Also, most other component groups contain a high concentration of FPs. As discussed in **section 3.1**, the total concentration of FPs in most end-products groups is however low, and three of five end-product groups showed concentrations below ≤ 6.0 %. 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.

[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 6: Average of estimated total PFAS concentrations (%) in components

Component group	**Components [1)]**	**Average concentration of FP (%)**
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	87.1
3	Electronic components (circuit boards, displays, injection units, flow meters, etc.), cables, batteries	35.7
4	Housings, containers, reactors, flame retardant plastic components	100.0
5	Paints, adhesives, potting compounds, binders, multi-component compounds, coatings	100.0
6	Membranes	62.9
7	O-rings, retaining rings, (flat) sealings	100.0
8	Lubricants (greases, oils), lubricant coatings, bearings/slide bearings	53.3

[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.

Table 7: FPs reported in components

Component group	PTFE	ECTFE	PVDF	PVDF-HFP	FKM	FFKM
1	+	+	+	+	+	-
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 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 the 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 primarily 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 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 0.6 tons; the concentration of FPs in waste is estimated to be 40.0 %. 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	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) or Standard work clothes, gloves (chemicals) + RPE
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	No filter system after extraction
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m³]	—
Waste tonnage [tons]	0.6
Proportion of FP in waste [%]	40.0
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 extrusion/injection molding/casting are highlighted (**Table 9**). Such tasks may for example be used for the manufacturing of membranes or pipes and may use FP raw materials.

Table 9: Process description – Extrusion/injection molding/casting

Process parameters	**Selection [1)]**
Process type	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) or Other
Process temperature	25 - 50 °C or > 150 °C
LEV	Partially available
Filter systems after LEV	No filter system after extraction or Other
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	Partially possible
Wastewater volume [m³]	0.30
Waste tonnage [tons]	11.3
Proportion of FP in waste [%]	0.5
Waste disposal route	Collected and disposed with other process waste or Collected and disposed separately

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

For the task of extrusion/injection molding/casting, the process temperature was either reported as 25 – 50 °C or > 150 °C. As these processes might involve heating, the potential for exposure is increased compared to other tasks, such as assembly. 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 reported for 80 % of responses related to these process steps. Furthermore, to control emissions, additional filter systems associated to the LEV were reported in 67 % of the related responses. General hall ventilation systems or heating, ventilation, air conditioning (HVAC) systems were also reported for 100 % of extrusion/injection molding/casting processes. Dissolving or casting steps on the other hand pose a very limited potential for emissions as no volatilization and/or decomposition of FPs is expected.

Wastewater may be generated, with a reported average annual wastewater volume of 0.30 m³. This wastewater is assumed to be related to cooling processes in case of extrusion or injection molding; while contact to extruded or molded parts cannot be excluded; the low wastewater volume indicates no continuous emission. As no measurement data are available, a more detailed analysis regarding substances and quantities of wastewater emissions cannot be performed. However, in relation to this cluster, companies stated that wastewater is treated in company-operated or municipal wastewater treatment plants (WWTP). Overall, the potential for emissions via wastewater of this process cannot be excluded but is considered limited.

The waste tonnage and FP concentration therein were estimated to be 11.3 tons and 0.5 %, respectively. Similar as described above, waste is disposed with other process waste but might also be collected and disposed separately.

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 – especially to air – 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. The own preparation of parts from raw material components is limited; it was also reported that LEV systems are in place. 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 built 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 on PVDF is expected 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 (pH ≥ 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 pH ≥ 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, and a range of applications are expected exclusively in the acidic range. However, it was also reported that the pH of contact media may range from acidic to basic conditions.

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	+	+	-	+
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	+	+	-	-

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, not all components 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. In this regard, it is expected that wear-and tear-effects will to a lesser or no proportion 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**.

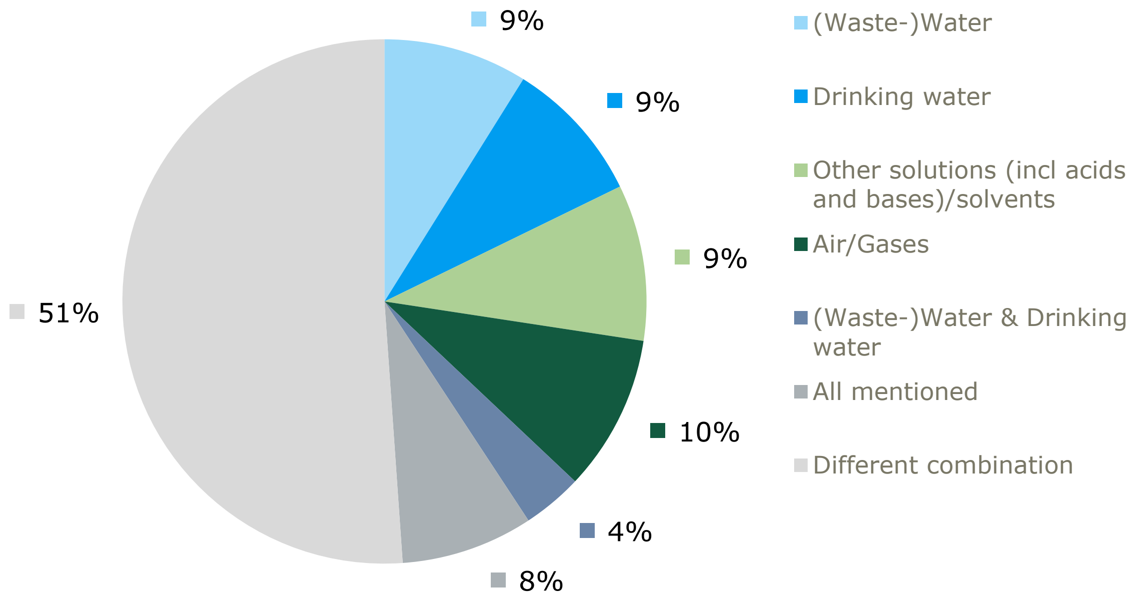

Figure 3: Overview on contact media of components during use

Participants were able to choose from different options and combinations of options: **Option1:** (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, 5 and 8[10]. Especially for the case of lubricants, FP-containing components may under certain circumstances be rinsed out during intended use. 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, this relates to end-products such as softening, dosing or membrane systems, which contain lubricated O-rings. Lubricants may also be used in components like valves or already applied as coatings to other 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 components such as valves or pre-coated parts have consequently not been considered here.

From data collected from figawa members, an average annual lubricant tonnage of 0.46 tons was identified, which is directly used in end-products mentioned above. FPs

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

concentrations in lubricants reportedly are 40 %, resulting in annual tonnages of 0.18 tons/a used. ECHA reported an emission range of 5 to 25 % for lubricants during the manufacture and use phase (ECHA *et al.*, 2023b). As this covers the whole sector of suppliers as well as consumers the emission range is considered highly conservative. Specifically for this cluster it has to be considered that not the total amount of PFAS used is in direct contact with the transported medium. Moreover, the main contact medium is drinking water, and FPs are practically insoluble in water (Korzeniowski *et al.*, 2023).

For the calculation of emissions, the lower end (5 %) of the emission range reported by ECHA was used. Emissions were calculated as 0.009 tons/a. Including a reported service-life of 11 years for softening and membrane systems and of 9.2 years for parts used in chemical dosing systems, roughly estimated annual emissions from use of end-products of an average company may amount to 0.0008 tons/a, or 0.8 kg/a. It is imperative to note that only a small proportion of companies reported the use of lubricants in their applications, and in contact to drinking water/wastewater or other relevant liquids. This estimate is therefore not applicable for the whole cluster and cannot be used for the assessment of total emissions.

It is in this regard also noteworthy that for drinking water, compliance with separate German regulatory limit values (PFAS-20[11]) is required and ensured[12]. It was also reported by at least one company that additional studies are performed to assess potential emissions from the use of their products.

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, only a limited number of components is in direct contact to media – such as water or wastewater – which provide an entry route of FPs into the environment. Wear-and tear may lead to emissions of FPs but given the long service-life and required durability of products, the potential for emissions is limited. For a small group of end-products, which use lubricants directly and are in contact to (waste-)water or other solutions, the potential for rinse off exists. The derived emission values are most likely an overestimate considering that the release range reported by ECHA covers the whole sector of lubricants, including manufacture. In any case, in relation to the total emissions of 123 to 225 tons/a (2020) estimated for the application of lubricants in the restriction proposal (ECHA *et al.*, 2023b), the emissions from the described end-products are small. In relation to the total emissions reported by ECHA, average annual emissions (0.009 tons/a) correspond to 0.004 to 0.007 % of total emissions. If related to the service life duration (0.0008 tons/a), a contribution of 0.0004 to 0.0007 % may be calculated. This has also to be put into relation that lubricants as such only make up a fraction of total PFAS and FP emissions (ECHA *et al.*, 2023b).

[11] PFAS-20 refers to non-FP PFAS which must not exceed a summed limit of 0.00010 mg/L from 12.01.2026.
[12] Zweite Verordnung zur Novellierung der Trinkwasserverordnung BGBl. 2023 I Nr. 159 vom 23.06.2023 (https://www.recht.bund.de/bgbl/1/2023/159/VO.html)

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 water 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**).

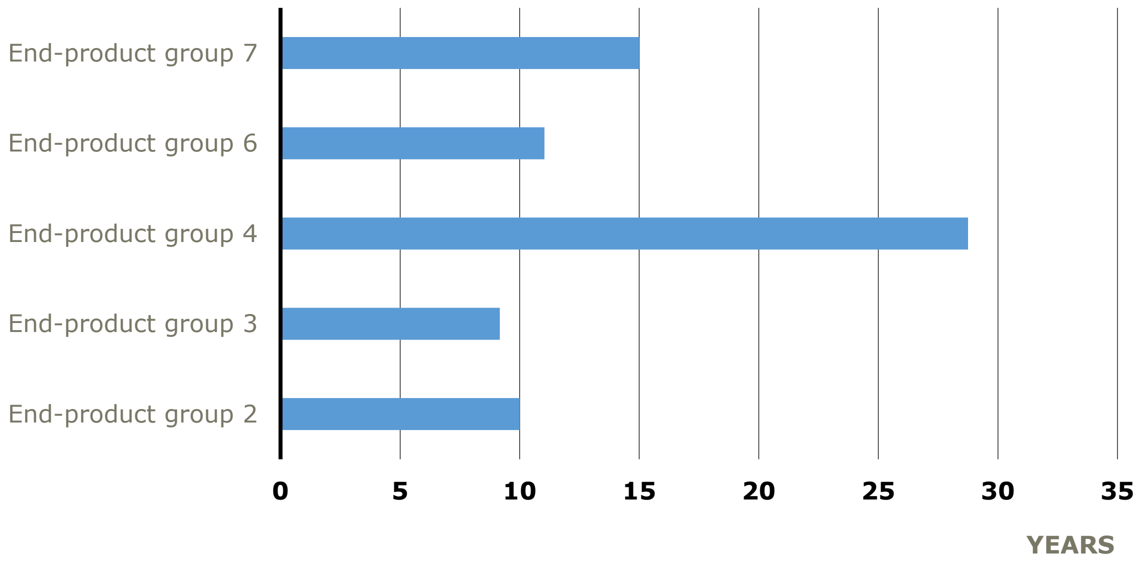

Figure 4: Average service-life duration of end-product groups

Groups are defined as **End-product group 2**: Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 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); **End-product group 7**: Meters, sensors, analysis tools and controls

It was also queried which proportions of waste – according to the participants market knowledge – are incinerated (including waste-to-energy), landfilled or recycled.[13] 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.

[13] 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).

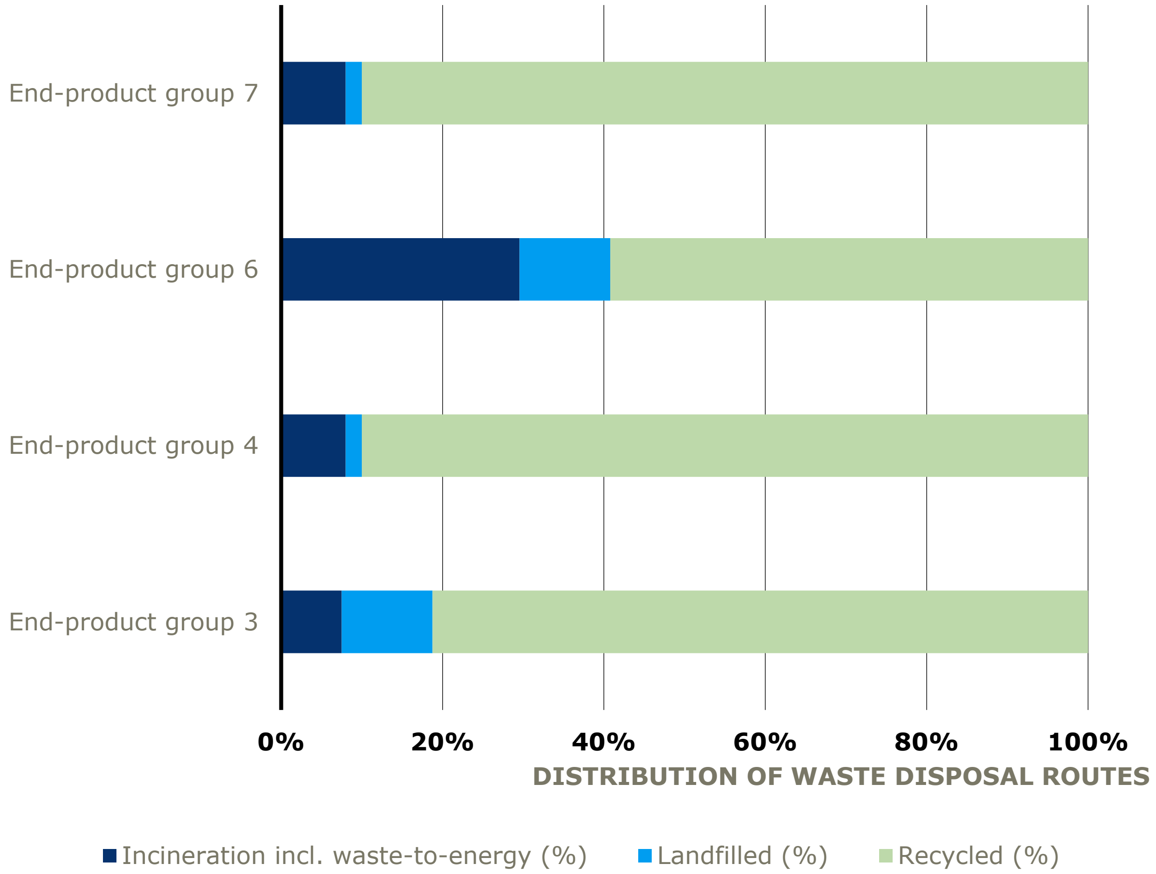

Figure 5: Assumed disposal routes of end-products

Groups are defined as **End-product group 2**: Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors for eduction of gases/liquids; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 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); **End-product group 7**: Meters, sensors, analysis tools and controls

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 (≤ 6.01 %). Fewer end-product groups – such as membranes – may have FP concentrations of up to 100 %.

Regarding landfilling, Lohmann et al. (2020) report that FP "landfilling […] leads to contamination of leachates with PFAS", mainly due to weathering and physical stress. 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 therefore 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) supports the stability of PTFE, stating – amongst others – that PTFE "was insoluble in water", and "was determined not to be biodegradable"; it is summarized that PTFE does "not partition to air, water, or soil" and that there is a "lack of transformation to other PFAS, such as perfluoroalkyl acids".

Recycling is most likely be related to metals or other valuable raw materials used in end-products, for which relevant recycling approaches exist. 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 ones are usually operating at higher furnace temperatures. Complete, uncatalyzed, destruction of PFAS is expected at temperatures > 1,400 °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 °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. 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 proposal[14] (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 incinerator 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.

[14] 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 of further research, and figawa members are supportive of such regulatory measures if proposed by authorities. Emissions may be caused by the use of lubricants if in contact with wastewater or drinking water. Overall, potential emissions are estimated to be small in comparison to emissions of other sectors and uses. It is important to note that drinking water itself is strictly regulated, to ensure high quality standards.

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, the use of lubricants when in contact with water or other liquid media, 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 [m³]	####
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 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) or Standard work clothes, gloves (chemicals) + RPE
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	No filter system after extraction or One-step membrane filter to reduce particles
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m³]	—
Waste tonnage [tons]	100.00
Proportion of FP in waste [%]	1.00
Waste disposal route	Collected and disposed with other process waste

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

Table 12: Process description – Solving/heating

Process parameters	Selection [1)]
Process type	Manually
Task is performed	Internally
PPE	Standard work clothes, gloves (chemicals)
Process temperature	50 – 150 °C or > 150 °C
LEV	No
Filter systems after LEV	n/a
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m³]	—
Waste tonnage [tons]	n/a
Proportion of FP in waste [%]	n/a
Waste disposal route	Collected and disposed with other process waste

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

Table 13: Process description – Mixing with additives/other FPs

Process parameters	**Selection [1)]**
Process type	Automatically or Both manual and automatic steps
Task is performed	Internally
PPE	Standard work clothes, overall/coat, gloves (chemicals), RPE
Process temperature	50 – 150 °C or > 150 °C
LEV	LEV
Filter systems after LEV	One-step membrane filter to reduce particles
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	Partially possible
Wastewater volume [m^3]	n/a
Waste tonnage [tons]	0.10
Proportion of FP in waste [%]	2.00
Waste disposal route	Collected and disposed with other process waste

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

Table 14: 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 (shirt/long-sleeve, long trousers, safety shoes/boots) or Standard work clothes, gloves (chemicals) or Other
Process temperature	15 - 25 °C (room temperature)
LEV	Partially available
Filter systems after LEV	No filter system after extraction or Multi-step membrane filter to reduce particles + additional filter steps
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	Partially possible
Wastewater volume [m^3]	70.01
Waste tonnage [tons]	0.30
Proportion of FP in waste [%]	2.00
Waste disposal route	Collected and disposed with other process waste

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

Table 15: Process description – Cleaning/rinsing

Process parameters	Selection [1)]
Process type	Both manual and automatic steps
Task is performed	Internally
PPE	Standard work clothes, gloves (chemicals)
Process temperature	25 - 50 °C
LEV	No
Filter systems after LEV	n/a
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	Yes
Wastewater volume [m³]	5.00
Waste tonnage [tons]	4400.00
Proportion of FP in waste [%]	n/a
Waste disposal route	n/a

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

Table 16: Process description – Transfer/weighing of raw material

Process parameters	Selection [1)]
Process type	Manually
Task is performed	Internally
PPE	Standard work clothes, gloves (chemicals) + RPE
Process temperature	25 - 50 °C
LEV	Yes
Filter systems after LEV	One-step membrane filter to reduce particles
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m³]	—
Waste tonnage [tons]	n/a
Proportion of FP in waste [%]	n/a
Waste disposal route	Collected and disposed with other process waste

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

Table 17: Process description – Other/additional step

Process parameters	Selection [1)]
Process type	Both manual and automatic steps
Task is performed	Internally
PPE	Standard work clothes (shirt/long-sleeve, long trousers, safety shoes/boots)
Process temperature	15 - 25 °C (room temperature)
LEV	No
Filter systems after LEV	n/a
Hall ventilation (e.g., HVAC)	Yes
Generation of wastewater	No
Wastewater volume [m³]	—
Waste tonnage [tons]	0.01
Proportion of FP in waste [%]	100.00
Waste disposal route	Collected and disposed with other process waste

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