September 2023

EPEE'S REPLY TO THE PUBLIC CONSULTATION ON THE UNIVERAL PFAS RESTRICTION PROPOSAL

Part II - Fluoropolymers

Executive Summary

Fluoropolymers are essential to the optimal performance of equipment and products that contribute to the decarbonisation of the energy system and buildings, and provide efficient heating and cooling solutions for domestic, industrial, commercial, and medicinal applications, as well as many others. The definition of PFAS given by the Restriction Proposal covers all fluoropolymers, and a potential ban would have a detrimental impact on all those crucial applications.

There are no viable, existing alternatives to fluoropolymers today that could fulfil the same criteria with the same level of efficiency and safety, and new components are likely to take years if not decades to be developed properly. Fluoropolymers are used for their sealing capacity, but also resistance to pressure and temperature, persistence, electrical properties and low friction. Fluoropolymers are also the safest way to transport refrigerants and avoid leakages of toxic and flammable gases.

The process of inventing, testing, certifying and scaling up the production of alternatives requires at the very least 10 years. In the shorter term, fluoropolymers would have to be replaced with older solutions and technologies, which would represent a significant loss in the efficiency of the equipment. Existing systems also have to be maintained and repaired with spare parts, meaning that a ban could reduce the lifecycle of products and create a massive amount of waste that would have to be treated properly in an environmentally sound manner.

To avoid a significant loss of efficiency for key products in heating and cooling and drastically slowing the deployment of decarbonisation solutions such as heat pumps, while allowing for safety requirements and citizens' health and well-being, **a full time unlimited derogation must be granted to fluoropolymers in RACHP applications, with a review clause after 10 years to assess the availability of alternatives**.

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I. Introduction

Disclaimer: Throughout this document, the term 'RACHP' shall be considered synonymous with the term 'HVACR' which is often used globally to represent the same or very similar industry sector as RACHP.

The European Partnership for the Energy and the Environment (EPEE) welcomes the opportunity to participate in the consultation by providing evidence and data on the RACHP sector to the ECHA responsible committees to support them in their review of the restriction proposal.

EPEE is the European association representing the entire value chain of the Refrigeration, Air-Conditioning and Heat Pump (RACHP) Industry since 2000. EPEE's membership is composed of over 48 member companies, as well as national and international associations covering three continents (Europe, North America, Asia).

As an expert association, EPEE supports safe, environmentally and economically viable technologies; works to ensure a better understanding of the sector in the EU; and proactively contributes to the development of effective European policies, regulations, and standards. EPEE and its members ensure that refrigerants are responsibly used in RACHP equipment, in an energy efficient, safe, environmentally sound, affordable, and reliable manner, over their entire lifecycle, including the equipment's End-of-Life (EoL). EPEE is presenting here its experience as a down-stream user, and not as an expert of fluoropolymers.

The applications that EPEE members cover can be divided by:

- Market types: residential, commercial, transport, industrial;
- Sector types: refrigeration, comfort cooling and heating, heating and/or steam production for industrial processes;
- Technology sub-types: stand-alone, direct expansion, chillers, flooded systems.

All applications are beneficial to society and operate in homes, industrial sites, office buildings and public buildings, including hospitals, airports and train stations. The magnitude of the sector is reflected in the 20% ratio of the entire global consumption of electricity. Heat pumps also improve the energy system via its demand side response and storage features.[1]

- **Heat pumps[2] and air-conditioning systems**
    - For residential purposes: space heating and cooling, and sanitary water heating with hydronic (air-to-water and ground-to-water) or air-to-air heat pumps;
    - For services: commercial and public sector buildings, space heating and cooling, and sanitary water heating, large systems for offices (chillers, variable refrigerant flow systems (VRFs), rooftop units…);
    - District heating and cooling;

[1] See for instance COM(2020)299, *Powering a climate-neutral economy: An EU Strategy for Energy System Integration.*

[2] 'A heat pump is a device that can provide heating, cooling and hot water for residential, commercial and industrial use. Despite the name, all heat pumps can provide both heating and cooling. They work well in nearly all types of climate. Heat pumps take energy from the air, ground and water and turn it into heat or cool air. This works due to what is known as the refrigerant cycle.' About heat pumps – European Heat Pump Association (ehpa.org)

  - Industrial uses: low temperature process heating (below 130°C) and high temperature water and/or steam for industrial processes, industrial building space heating and cooling, and industrial drying;
  - Air-conditioning for cars, vans, trucks or large vehicles like buses, trains or marine vessels and ships;
  - Waste heat recovery, with the purpose of enhancing circularity and to reduce energy consumption from industrial and commercial activities;
  - For data centres where efficient cooling is key, but also heat pumps that recover waste heat.
- **Refrigeration**:
  - For residential purposes including refrigerators and freezers;
  - For food retail and food service refrigeration including standalone units, chillers, condensing units and centralized refrigeration systems;
  - For industrial cooling in applications such as food and beverage production, processing and packaging, chemicals, pharmaceuticals, oil and gas, etc;
  - For transport of goods in vans, light trucks or larger systems like trailers and containers such as shipping containers (reefers). Those systems are essential for securing the cold chain for perishable food products, medical products (e.g., medicines, vaccines, blood, and plasma), sensitive electronics, and other critical products that rely on specific controlled temperatures for preservation.

This part of the submission covers specifically fluoropolymers. For the part related to F-gases, please refer to Part I: F-gases/refrigerants.

II. Essential functionalities in RACHP equipment – Fluoropolymers

A. Missing Use in the PFAS Restriction Proposal

The PFAS Restriction Proposal does not specifically mention or consider the use of fluoropolymers containing parts inside the components of RACHP equipment. All fluoropolymers fall under the proposed chemical definition of PFAS in the restriction proposal. **The use of fluoropolymers in components is essential for the functionality and tightness of RACHP systems.** The criticality of fluoropolymers and their unique properties is described below, alongside a list of their different applications.

B. Harsh operating conditions within RACHP equipment

The environment inside RACHP systems is harsh because of the pressurized refrigerants and oils interacting, and potential degradation of the materials-of-construction. The materials used in components must therefore be able to tolerate and operate in these conditions while retaining sufficient mechanical and physical properties over time (often greater than 15 years of use-life). While some metals and ceramics work well in these environments, polymers are particularly susceptible to break down in these conditions.

This challenge makes it very difficult – perhaps impossible – to find alternatives with the necessary endurance for long-term use in the RACHP industry. Fluoropolymers have the necessary properties and have been widely used for many decades. The fluoropolymers provide an unmatched multitude of high-performance properties to deliver the required functionality to the components used in RACHP. It is important to understand that many alternative materials may be acceptable for just one or two of the required properties of a specific component, but not all the required properties for that component. **Fluoropolymers satisfy several needed properties for the RACHP sector simultaneously.**

The following critical functional properties are required of the fluoropolymers during RACHP equipment operation:

1. <u>Sealing</u>

Fluoropolymers are used in sealing applications in the RACHP industry to prevent the release of refrigerant into the atmosphere, e.g. into rooms that may be occupied by people. Leakage is a safety concern from both an asphyxiation and flammability perspective. Most modern-day low global warming potential refrigerants are mildly flammable, so the sealing provides an extra safety function.

The ability to remain conformable (i.e. not become brittle) at low temperatures is critical to the effectiveness of RACHP seals. The seals must remain resilient so that they conform to the mating surface and seal effectively. The same requirement is necessary for high temperatures, where the seals must not excessively soften or thermally degrade, which would adversely affect the seal.

2. <u>Temperature and Pressure Resistance</u>

Compression of the refrigerant in the system causes high gas pressure, temperature swings, and phase changes of the refrigerant (both liquid and vapor states of the refrigerant may exist). Temperatures can range from -50°C to 175°C and pressures can range from near a vacuum and up to 45bar (R410A), or up to 120 bar for CO_2 systems. Under these conditions, the refrigerant can react with or be absorbed by the polymeric materials and cause rapid gas decompression, which often causes catastrophic blistering of the plastic RACHP component.

Figure 1 below is a bar chart that compares many non-fluoropolymers with two fluoropolymers (i.e., PTFE and PVDF) in terms of their acceptable service temperature range. The darker shaded upper bar denotes longer-term use, and the lighter shaded lower bar denotes short-term use. For the RACHP sector, only the upper bar should be considered, given the long operational lives of products.

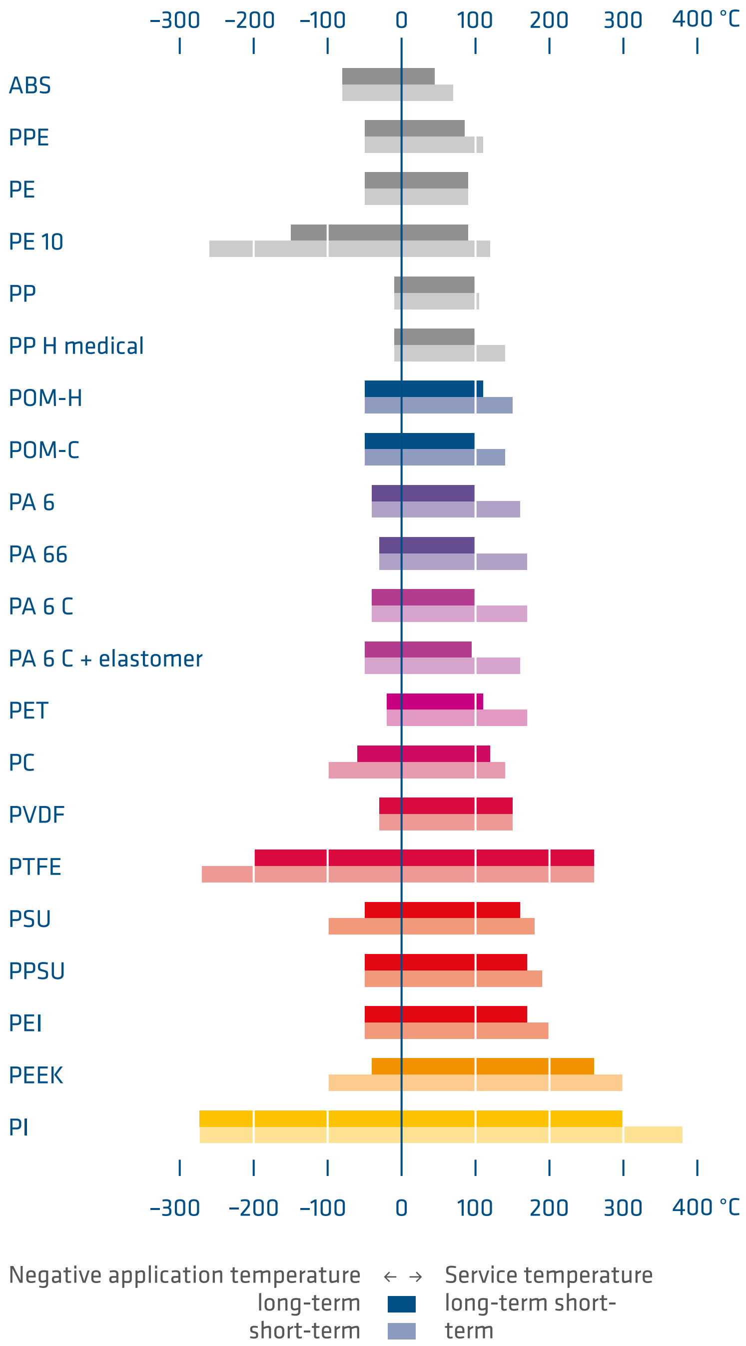

Figure 1: Service Temperature Range of Polymers for Short- and Long-Term Use[3]

[3] Plastics with low temperature properties. Ensinger. (n.d.). https://www.ensingerplastics.com/en-us/shapes/plastic-material-selection/low-temperature

Although this chart only shows a single property (i.e., temperature resistance), the advantage of the fluoropolymer PTFE over most non-fluoropolymers is clear. The fluoropolymer PVDF has less temperature resistance, but in RACHP products is mainly used for electrical applications when the specific use temperatures are not as extreme.

Most RACHP applications require more than one property to be present simultaneously. For example, from Figure 6, the service temperature range of PI (polyimide, a non-fluoropolymer) is superior to PTFE. However, PI has other deficits: it is harder (i.e., less physically compliant) and would therefore have sealing application limitations; the frictional properties relative to PTFE are not equivalent; and it is known to exhibit higher average friction than PTFE.

3. <u>Persistence/Longevity and Chemical Inertness</u>

Persistence is viewed negatively in reference to fluoropolymers, however, persistence is why the industry uses fluoropolymers. Persistence is the general descriptor that also encompasses many positive attributes, such as chemical inertness and temperature resistance. Persistence is what allows the products to have long useful lives, and product longevity reduces waste. The chemical inertness due to the strong carbon/fluorine bonding of fluoropolymers enables them to be compatible with the environment in RACHP systems where they must stand up to metals, oils, and refrigerants in liquid and gas phases.

Any alternative material selected would also need to be persistent whether it is a fluoropolymer or not. Any polymeric material must be very resistant to aging to be able to hold up to that many years of use, especially when exposed to refrigerant, oil, high temperatures, and high pressures which tend to accelerate aging in polymers. The overall combination of these operating conditions can cause several destructive events to the non-fluoropolymers, such as: brittleness (hardening), softening, swelling and cracking.

4. <u>Electrical Properties</u>

Fluoropolymers likely permeate almost every electronic and electrical device within the RACHP sector. The electronic devices have several important functions, many of which are safety related. They also provide monitoring and control functions, such as thermostats, fans, safety leak detection sensors and variable speed drives for Heat Pumps and Cooling applications. Fluoropolymers are found in the following RACHP products (please note this is not an exhaustive list):

- Safety pressure protectors
- High temperature safety cutoff protectors
- Motor materials-of-construction (for compressors and actuators)
- Wire and cable insulation
- PCB as a component (these are used as a fiber-reinforced fluoropolymer layer)
- LCDs and displays manufacturing
- Film capacitors
- FPs are also used in semiconductor manufacturing, including all populated components like transistor, diode and power module

The electrical functional properties required of fluoropolymers in these RACHP applications are the following (again, this is not an exhaustive list):

- Low dielectric constant
- Low intrinsic flammability

- Water and general corrosion resistance
- Stable in terms of physical and mechanical property retention in the presence of the RACHP working environment (no blistering, no softening, no hardening, tensile strength, compressive strength, ductility/flexibility, etc.)
- Ability to function and remain durable over time in the presence of high pressure and temperature gradients

5. Low Friction

Relation to oil and refrigerants

There are many moving parts inside a RACHP system (compression mechanism, valves, etc.) and a certain oil content within the circulating refrigerant is needed to avoid friction-based riveting and system malfunction. Fluoropolymer components are uniquely qualified to maintain low friction even during times of oil dilution and viscosity reduction. Low friction is important because it prevents wear, increases product life, and lowers friction-induced power losses (less energy use). Hence, one of the key reasons why RACHP products last so long is because of the use of fluoropolymer bearings and seals which have intrinsically low friction. The low friction inherent in fluoropolymers compensates for the reduction in the oil viscosity. Figure 2 shows the complex interdependencies of temperature pressure and oil solubility versus the viscosity of the oil. If the viscosity becomes too low the friction will become too high, potentially damaging the system. As the system operation by definition has high temperature gradients, steep pressure drops and often cut in and out of operation, the friction between component parts is not constant but variable and complex. Fluoropolymers mitigate the changing conditions and ensure stability.

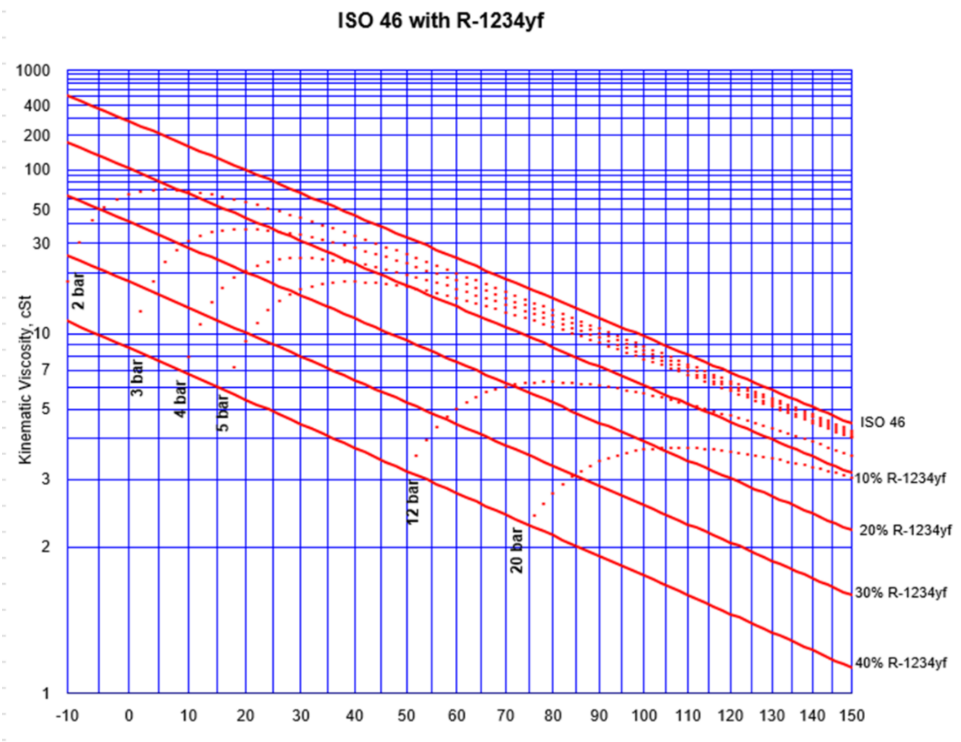

Figure 2: Viscosity of ISO 46 Centistoke oil with different amounts of R1234yf at different pressures and temperatures[4]

[4] Shrieve Chemical Co. Shrieve Chemical, 1442 Lake Front Circle Suite 500 The Woodlands Texas 77380 USA.

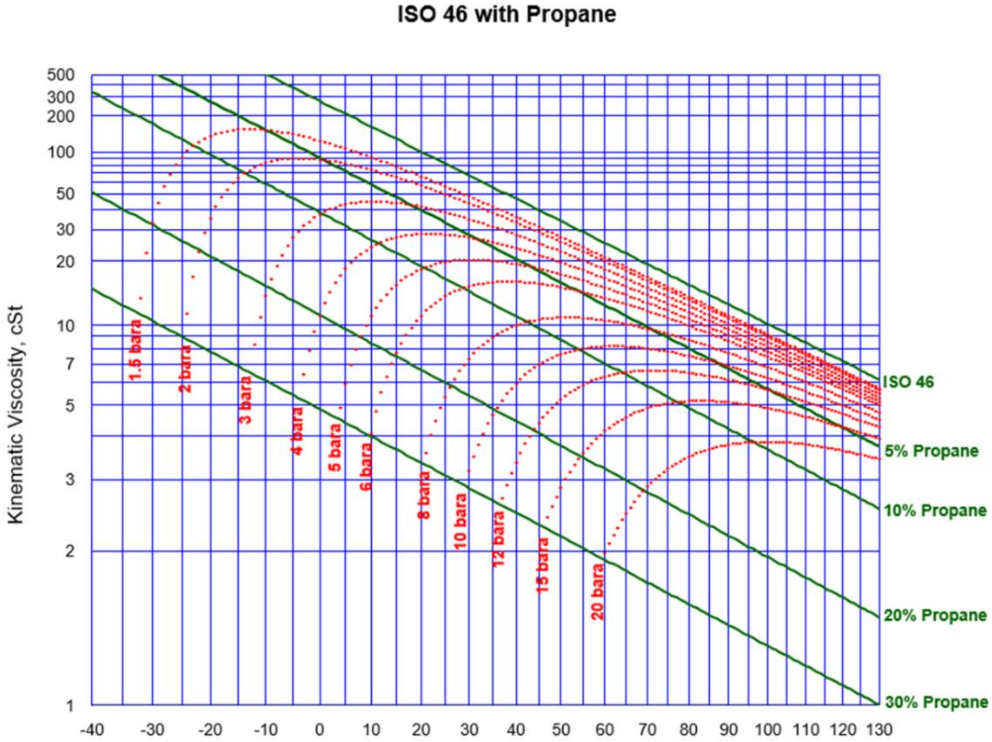

Figure 3: Viscosity of ISO 46 Centistoke oil with different amounts of propane (R290) at different pressures and temperatures.[5]

A third-party bearing company[6] did independent tribological testing. Four types of common bearing materials were tested, including one that is used in the RACHP industry. The testing was performed both with and without lubricant (dry). The 'dry' testing was used to simulate oil washout due to liquid refrigerant, which periodically occurs with certain applications or operating conditions. These tests were performed on a bench tribometer. The testing conditions are shown in the graphs. The ordinate axis for both charts is the percentage of friction increase relative to the normal PTFE-containing bearing (called 'PTFE-basis' on the chart). The three other bearing materials were engineered composite polymers (PVDF and PEEK) and one aluminium alloy.

The following graph (Figure 4) from a third-party bearing supplier shows the results for lubricated testing. Note the dramatic increase in friction of the other three bearing materials relative to the PTFE containing (PFAS) bearing material. Lower friction is preferred for several reasons within the RACHP industry, including lower power requirements and better system performance/efficiency and reliability.

[5] Shrieve Chemical Co. Shrieve Chemical, 1442 Lake Front Circle Suite 500 The Woodlands Texas 77380 USA
[6] Rheinmetall AG, Rheinmetall Platz 1, 40476 Dusseldorf in Germany

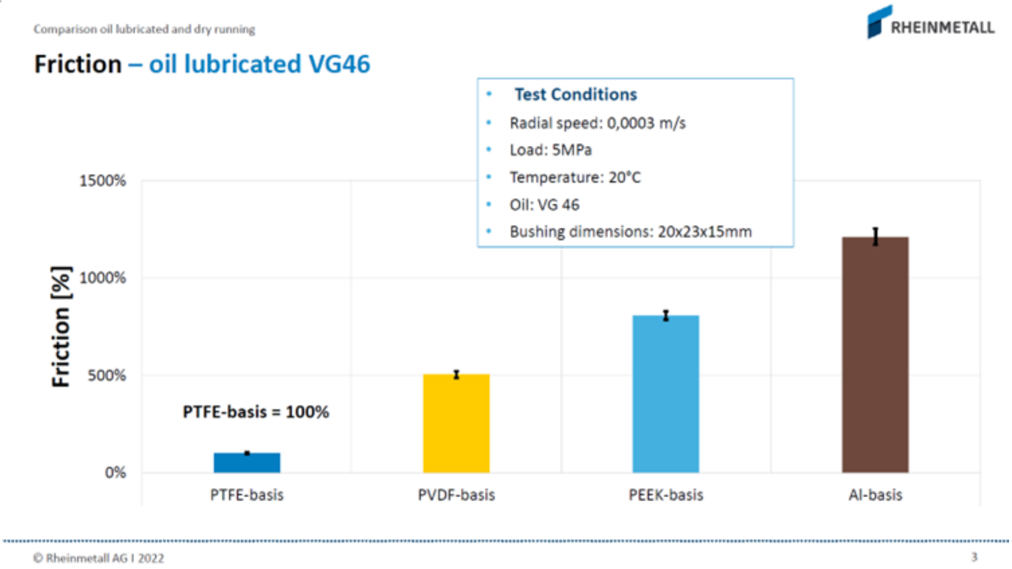

Figure 4: Amount of friction when lubricated compared to PTFE

The next graph (Figure 5) shows the results for the dry running conditions. Here again, the PTFE bearing material (often used in the RACHP industry), performed the best (lowest friction). Also note the aluminium bearing alloy did not complete the test because it seized due to very high friction.

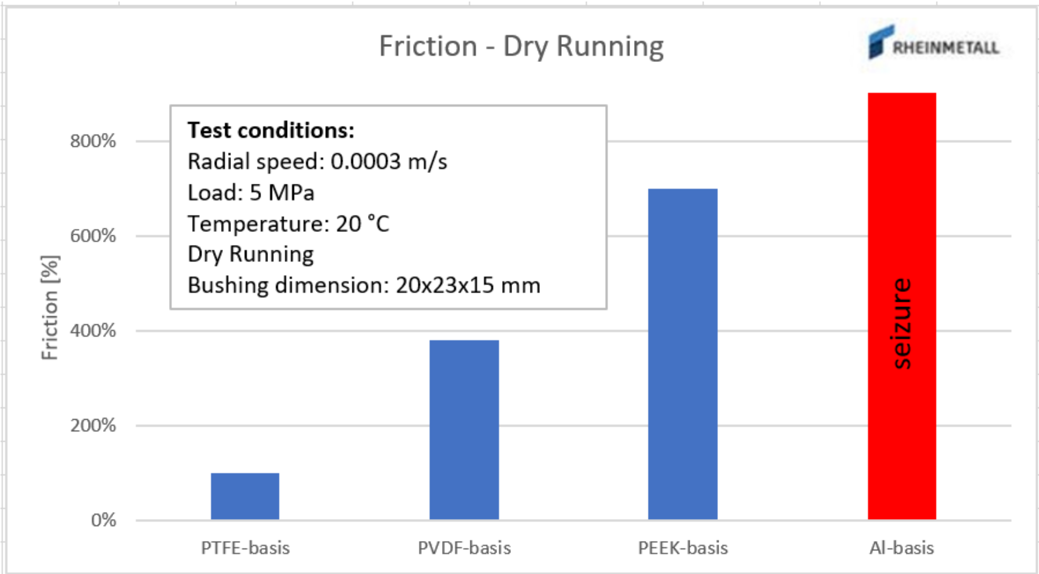

Figure 5: Amount of friction without lubrication compared to PTFE

C. Components usage of fluoropolymers – results of a survey among EPEE members

EPEE conducted an internal, anonymous survey of its members on the usage of fluoropolymers in RACHP systems. The survey is summarised in Annex A (Table 1 and 2, below) and tells in which components the main fluoropolymers are used, the reasoning for their use, the possible substitution implications and the justification of a REACH derogation. Components referred to in the tables are shown in Figure 6.

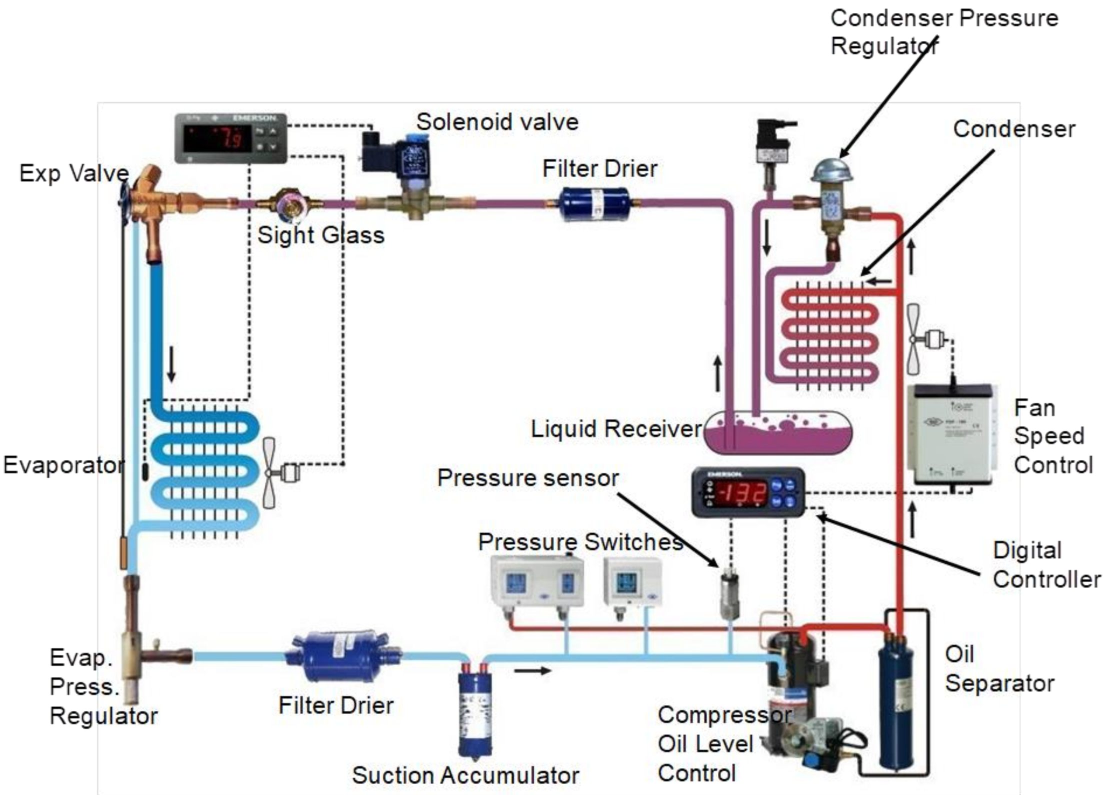

Figure 6: Outline of a simple vapor compression system with related components (Copeland)

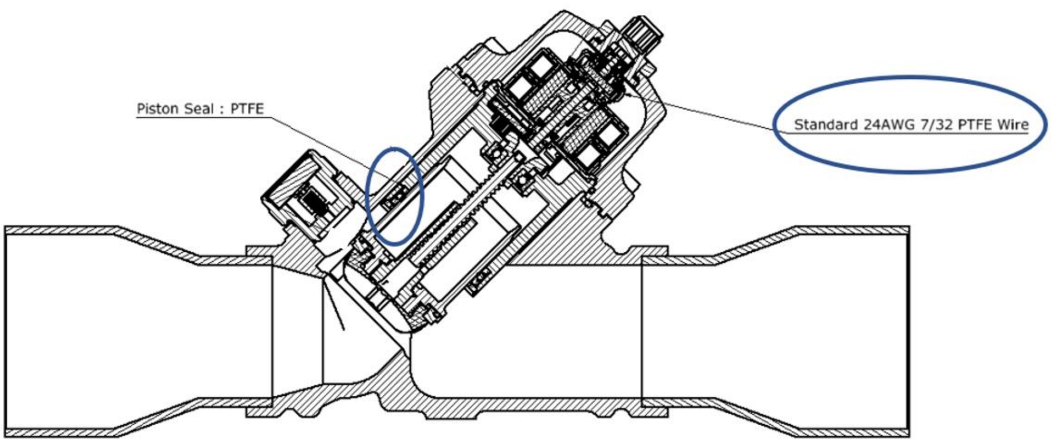

Figure 7: Electronic expansion valve (Danfoss) with PTFE seal and wire (Danfoss)

Figures 7 and 8 are examples of usage of PTFE in an expansion valve where the piston is subject to big variation of pressure gradients and temperature shifts. At the same time, it needs to move the piston while ensuring zero leakage from high to low pressure. Figure 9 shows two common types of valves for refrigeration systems. The Solenoid valve[7] on the right uses a variety of different fluoropolymers.

[7] A Solenoid valve is a type of valve controlled by an electric current. When electrically energized or de-energized, it will either shut off or allow fluid flow.

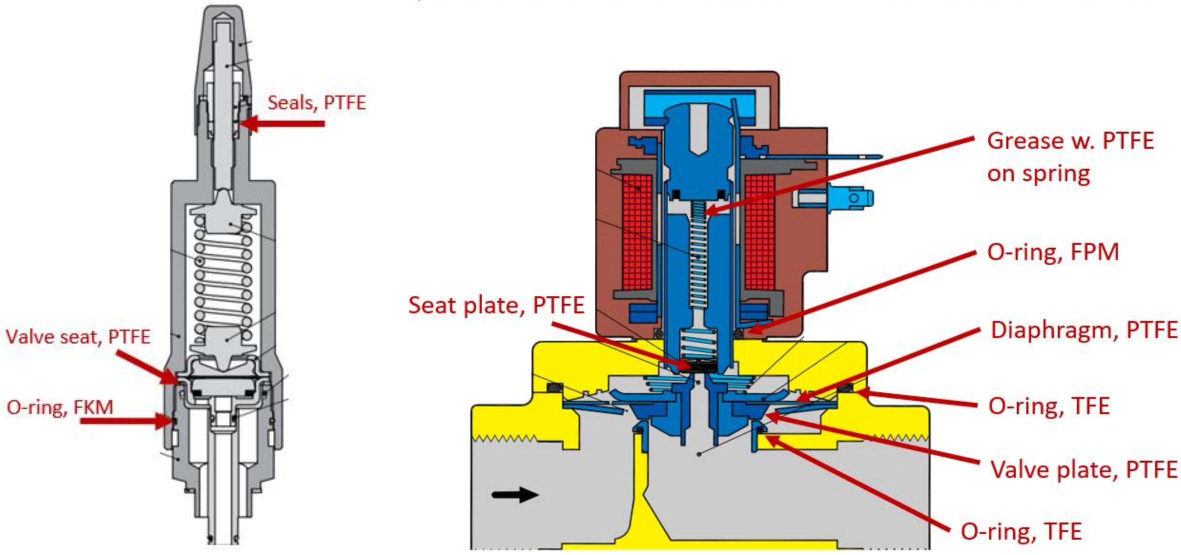

Figure 8: Pilot valve (left) and Solenoid valve with numerous fluoropolymers. (Danfoss)

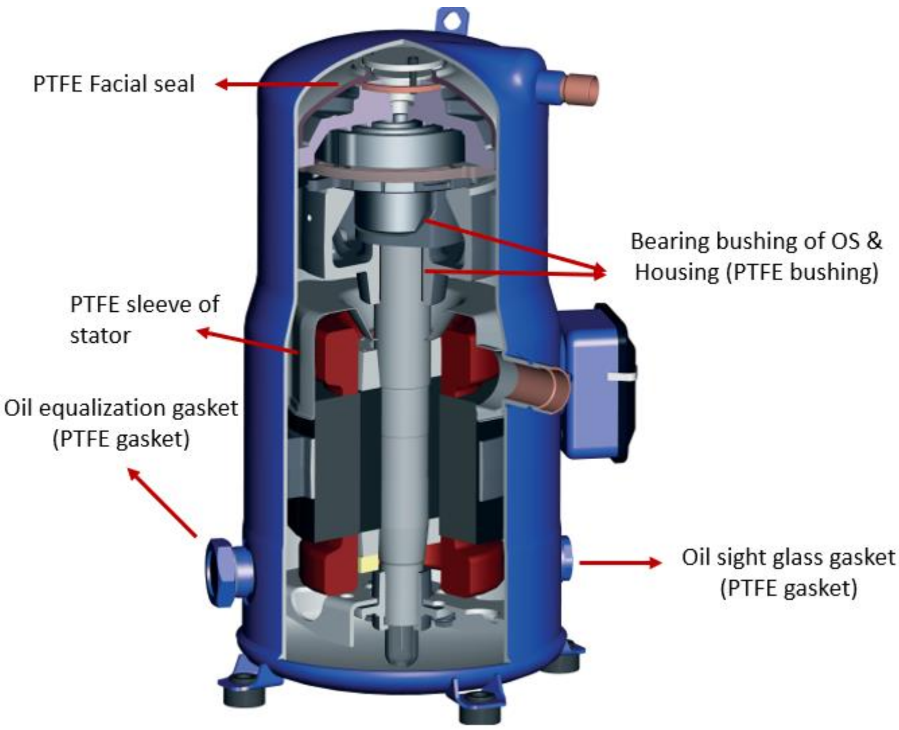

Figure 9: Scroll Compressor with multiple PTFE parts. (Danfoss)

The Compressor in Figure 9 is a mainstream scroll compressor used for many applications ranging from refrigeration to air conditioning and heat pumps. In the past, scroll compressor technology used to apply bearings were made from aluminium. In general, its performance was quite poor, with limited compressor lifetime and limited ability to support big loads. Some years ago, the bearing technology evolved to use material with PTFE in the composition. There is no other technology available to replace this material in the short/mid-term, except to move back to aluminium with all its drawbacks.

Consequently, the compressor lifetime would be reduced, with an estimated 80,000 additional compressors to be replaced in the field from 2024-2034, creating a significant impact on sustainability. In addition, there would be limited operational envelope and ability to support load, which would create limitations for heat pumps to achieve necessary temperatures for sanitary water without a complementary electrical heater. Efficiencies would decrease and many products would not meet EU Ecodesign requirements.

Before the use of fluoropolymer, previous components included substances such as lead and were eventually banned. An exemption for leaded bearing for "bearing shells and bushes for refrigerant-containing hermetic scroll compressors" for RACHP applications was in place up until July 2021, and then fully banned.[8] This led to an increase in the use of fluoropolymer (here, specifically PTFE) in the sector as an alternative to lead.

6. Transport of Refrigerants

To stock, transport and handle any kind of refrigerants (including non-fluorinated ones), the gas industry needs to pack refrigerants in tanks and cylinders (under-pressure equipment). Tanks and cylinders have accessories such as manometer, valves and safety valves fixed on the under-pressure equipment.

To avoid any leakage during the service life of the under-pressure equipment, accessories like joints need to be appropriately fixed. The service life of such equipment is 10 years (five years for ammonia). The better-known way to fix accessories on under-pressure equipment is PTFE (commonly known as Teflon), which can resist any type of refrigerant and condition (temperature, humidity, pressure).

Figure 10: example of a joint with PTFE.

There are alternatives such as pastes, but they are not technically equivalent to PTFE. Without PTFE or other specific fluoropolymers joints, the gas industry may face leakages on gas tanks and cylinders, which may affect the safety of installations in terms of flammability and toxicity, as well as the risk of environmental damage.

To be sustainable and reliable, the gas industry needs fluoropolymers, in particular PTFE, to be able to keep gas tanks and cylinders safe for everyone (whatever the type of gas).

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[8] Under the Directive 2011/65/EU, on Restriction of Hazardous Substances, see the latest update with the Commission Delegated Directive 2017/1010: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32017L1010

III. The RACHP Sector in the U-PFAS Restriction Proposal

A. The potential impact of a ban on the RACHP applications

As shown previously, a universal ban would have a significant impact for RACHP equipment from the current proposal:

- Fluoropolymers that fall under the PFAS definition in the proposal are widely used in RACHP components such as compressors, valves, controls, variable speed drives, leak detection electronics, etc. These systems require sealing materials and bearings that can withstand high pressures, and a wide range of temperatures to operate at their best. This specifically includes PTFE, PFA, FEP, FKM FEPM, ETFE, PVDF, PFPE…
- These fluoropolymer materials are highly resilient and provide excellent sealing and frictional properties that are required to minimise leakage of refrigerants and provide energy efficient (low friction) bearings. Such leakage leads to both direct greenhouse gas (GHG) emissions and to reduced energy efficiency and therefore increased energy-related (indirect) GHG emissions.

Therefore, banning the use of fluoropolymers in RACHP systems would likely lead to increased GHG emissions (as alternative sealing materials have inferior properties) and would require significant re-engineering – redesigning of thousands of different components used in and specific to the RACHP sector. While there is a time unlimited derogation proposed in the Restriction Proposal for “refrigerants in RACHP equipment in buildings where national safety standards and building codes prohibit the use of alternatives”, this derogation does not cover fluoropolymers, making it pointless as equipment will not properly function without fluoropolymers.

A broad ranging PFAS ban without any fully considered derogations would impede the optimal refrigerant choice for new equipment, likely hindering the ongoing and future R&D towards the development of even safer and more energy-efficient devices.

1. The lack of alternatives to fluoropolymers

Against the above background, the RACHP industry would face several innate constraints on the component side. Fluoropolymers work in complex conditions and with inherent operating limitations such as very high pressure, high temperature, oil resistance and refrigerant resistance. Without fluoropolymers proper operation of the equipment would not be possible. This is why the ongoing use of fluoropolymers is absolutely crucial.

There is no viable, existing current alternative to fluoropolymers for the majority of its applications and uses in the RACHP sector. A transition to alternative solutions would require in any case extensive development and testing. These processes (as shown below in Figure 11) ensure that the alternatives meet safety, performance and efficiency standards while maintaining compatibility with existing infrastructure and equipment. A sufficient timeframe is necessary to conduct comprehensive research, design and testing phases.

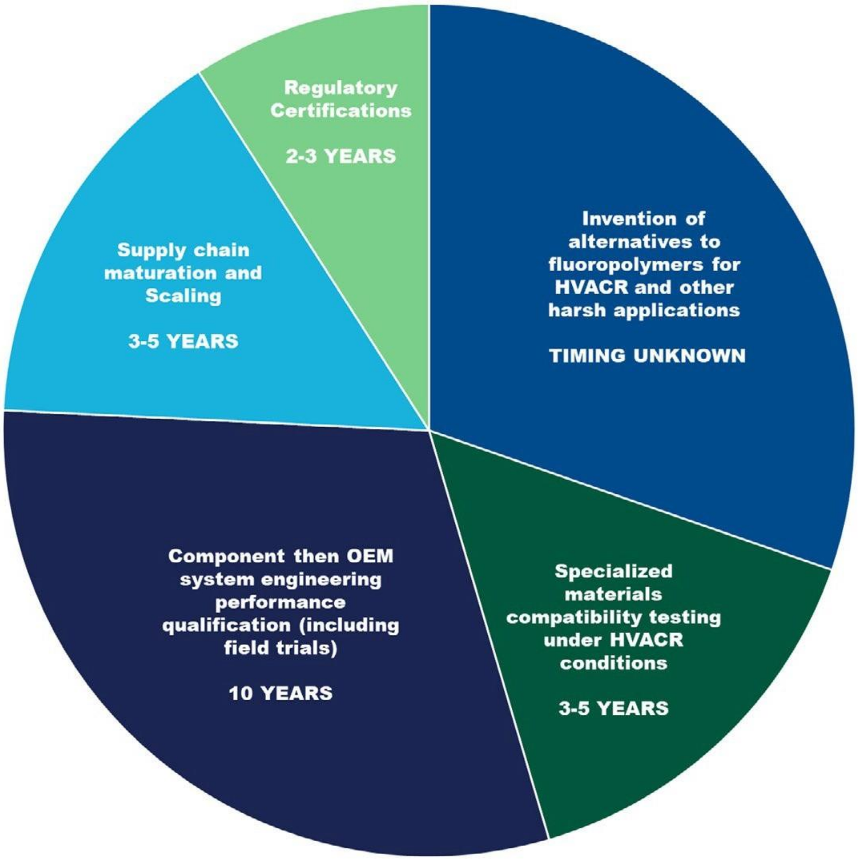

Figure 11: Internal estimation of time for developing alternatives to fluoropolymers, based on experiences conducted by the industry.

Furthermore, considering the time and investment needed to find innovative components, a ban could mean reverting to older technologies and a loss of efficiency.

2. Recommendation for maintenance and spare parts

In coherence with our recommendation of providing a time unlimited derogation to fluoropolymers for the RACHP sector, we also recommend a **time unlimited derogation for the maintenance and repair of systems.**

Spare parts: Under the PFAS proposal, it is necessary to consider the inclusion of a derogation for spare parts in order to ensure the repairability and continuation of the lifecycle of products. Spare parts play a vital role in maintaining and repairing products, enabling their longevity and reducing the need for new product purchases. By allowing the availability of spare parts, we support a circular economy model where resources are conserved, and the lifecycle of products is extended while the environmental footprint of a product is reduced.

This is why a full time-unlimited derogation for spare parts from the PFAS ban is the most viable solution to ensure that existing spare parts can continue to be utilized without unnecessary waste.

Threshold for PFAS: The Restriction Proposal foresees a ban on manufacture, use and placing on the market of PFAS if they are part as a constituent or if they are present in a mixture or in an article.

For fluoropolymers, the proposed concentration values will make the recycling process almost impossible and hamper the principle of circular economy in the RACHP sector[9], but are also impractical to assess due to current measurement and sampling limitations[10]. More realistic thresholds that would be aligned with existing REACH concentration limit thresholds are needed.

3. Exemption for export of equipment

The proposed use prohibition will affect the export (outside EU to third countries) position of producers (equipment, components,….). To secure global competitiveness, the export should be exempted, otherwise the prohibition will result in a technical barrier for trade.

B. End-of-Life of fluoropolymers

The Waste Framework directive (2008/98/EC) strengthened the waste prevention principle, including for electrical and electronic equipment, and the proper separation of waste. However the End-of-Life (EoL) treatment of electrical and electronic waste and their components is more precisely covered by the Waste Electrical and Electronic Equipment (WEEE) Directive.

The WEEE Directive and its treatment standards are setting the conditions for an environmentally-conscious treatment of Electrical and Electronic Equipment (EEE) at EoL. The WEEE Directive even requires producers to disclose treatment information to treatment operators and recyclers for each type of EEE placed on the market. A central online platform was established (the Information for Recyclers Platform (i4R)). The recycling information is linked to presence and location of materials and components requiring separate treatment.

Following the restriction proposal on the use prohibition and more specifically on the prohibition to place it on the market in articles, this results in a prohibition for proper waste treatment at EoL.

In view of safeguarding the principles of circular economy and avoiding massive future landfill a complete derogation from the restrictions is required for fluoropolymers, in alignment with a full-time unlimited derogation for the placing on the market of fluoropolymers. Activities for the recycling and reclamation of fluoropolymers also must still be allowed.

Regarding the end-of-life of fluoropolymers, there is no specific regulation applicable to the RACHP sector. Fluoropolymers can be either disposed of in landfills (as fluoropolymers are inert it can be a solution if the separation from other materials of the unit is not practical), re-used/repurposed or incinerated. Almost 84% of all fluoropolymer applications (beyond the use in the RACHP sector) were treated with incineration with energy recovery (72%) and thermal destruction (12%), and only 3% was recycled.[11]

[9] See the submission of the EFCTC in alignment with this recommendation on impurities thresholds.

[10] See for the perspective of the waste sector, the submission of the Confederation of European Waste-to-Energy Plants (CEWEP).

[11] *Fluoropolymer waste in Europe 2020 - End-of-life (EOL) analysis of fluoropolymer applications, products and associated waste streams.* Conversio Market & Strategy GmbH, https://www.ft.dk/samling/20222/almdel/euu/spm/49/svar/1951975/2698345.pdf

C. Fluoropolymers Are Different to Other PFAS, and Consideration of Non-fluoropolymers

PFAS that have traditionally been shown to be of concern are those that have low molecular weights and are likely to be mobile, bio-accumulative, and toxic. Fluoropolymers have high molecular weight, are non-mobile (not water soluble), non-bio-accumulative, non-toxic and pose little risk to human health and the environment. Based on the physicochemical, biological and (eco)toxicological properties of commercial fluoropolymers, >96% of major fluoropolymers are considered to meet the Organisation for Economic Cooperation and Development's (OECD) Polymer of Low Concern (PLC) criteria per existing and on-going studies. A total of 38 fluoropolymers are commercially available out of 4700+ PFAS.[12]

The following schematic shows the 13 criteria that the OECD has identified to define Polymers of Low Concern:

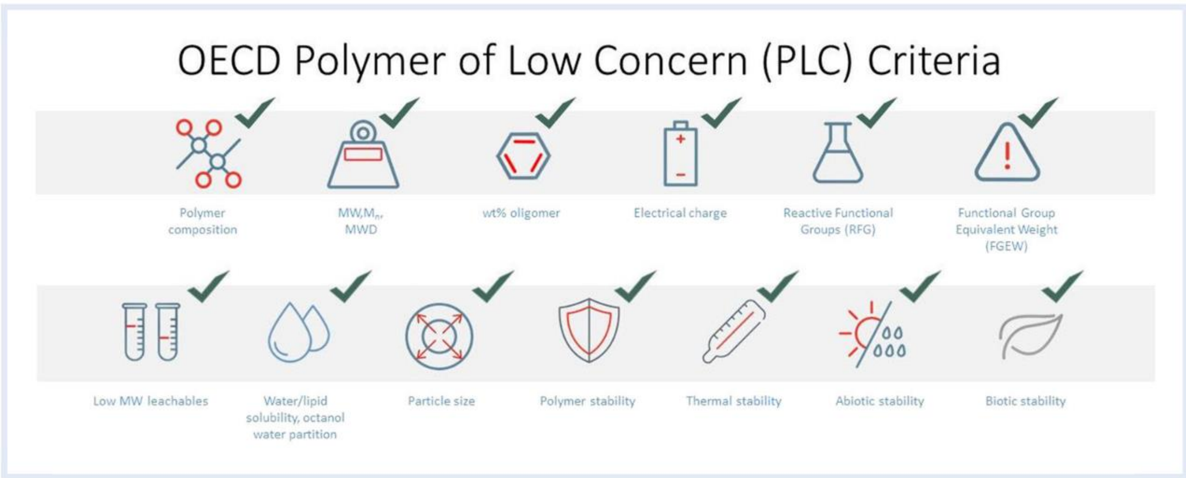

Figure 12: Criteria for a polymer to be a polymer of low concern[13]

Non-fluoropolymers are also used in many industries, including the RACHP sector, and are also important to the good functioning of equipment. PFHxA, BPAF and HFEs are not mentioned in detail in this submission due to a lack of sufficient data at this stage, but are also key substances whose utility cannot be overlooked. HFEs, for instance, are used by industries as a solvent.

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[12] Buck, R. C., Korzeniowski, S. H., Laganis, E., & Adamsky, F. (2021). Identification and classification of commercially relevant per- and poly-fluoroalkyl substances (PFAS). *Integrated Environmental Assessment and Management*, *17*(5), 1045–1055. https://doi.org/10.1002/ieam.4450

[13] Korzeniowski, S. H., Buck, R. C., Newkold, R. M., kassmi, A. E., Laganis, E., Matsuoka, Y., Dinelli, B., Beauchet, S., Adamsky, F., Weilandt, K., Soni, V. K., Kapoor, D., Gunasekar, P., Malvasi, M., Brinati, G., & Musio, S. (2022). A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers. Integrated Environmental Assessment and Management, 19(2), 326–354. https://doi.org/10.1002/ieam.4646

D. Recommendation for a Review Clause

As indicated and justified previously, EPEE recommends a time-unlimited derogation for fluoropolymers as they are essential to the efficiency and safety of the RACHP equipment, but **with a review clause after 10 years** to assess the availability of alternatives and their efficiency. The RACHP sector will likely innovate and there is potential for new technologies and components, but this process could take a significant amount of time as indicated previously in Figure 1.

IV. Conclusion

The proposed universal PFAS restriction now under review by ECHA would have a significant impact on the RACHP sector, if it goes ahead as proposed. In light of the green transition and the fundamental societal dependence on the deliverables like cooling, heating and refrigeration of food, <u>EPEE recommends:</u>

- A full **time-unlimited derogation for the RACHP sector for fluoropolymers, with a review clause after 10 years to assess the availability of alternatives;**
- A full time-unlimited derogation for spare parts, waste treatment (especially as fluoropolymers are inert) and export;
- Setting realistic concentration thresholds that would not hamper the circularity of the components.

In light of the above, EPEE would like to emphasise that:

- Alternatives to fluoropolymers, in the short- and medium-term as innovation will take time, would be older solutions and technologies that would decrease efficiency, reduce the lifetime of the products and generate more waste.
- All fluoropolymers fall under the proposed definition in the proposal. These substances, such as PTFE and FPM, among others, are critical to most of the components which make these systems run efficiently and at best performance. This includes vapour compression systems which ensure the smooth, efficient and optimal performance of RACHP equipment and systems, including key applications such as comfort heating and cooling, refrigeration, air conditioning, etc.
- Fluoropolymers are pivotal in their embedded design of the components and cannot be replaced by drop-in materials. The consequence of the possible ban as proposed would therefore be a forced, immediate need to completely redesign most platforms, while it is unclear when (or even if) efficient alternatives to fluoropolymers will be invented.

More broadly, EPEE believes the current proposal is not proportional and the risk associated with our uses is not unacceptable. For us as users, the benefits of fluoropolymers (intrinsic safety for fluoropolymers) together with their socioeconomic value (such as their sealing properties that avoid leakages) outweigh the concerns of regulators related to risk from their manufacture, use and end of life.

Annex A

Tables extracted from an internal EPEE survey among its members (2023): Main Fluoropolymers and their usage, potential replacement, and derogation justification.

Table 1. PFAS Fluoropolymers (simplified list)

PFAS fluoropolymer	Location in RACHP products (including parts)	Approx. timeline for its substitution (in n° of years)	Circumstances that justify a REACH derogation (*see also table 2 for overview summary)*
PTFE Polytetrafluoroethylene	**Filters**	PTFE used for a wide range of applications in HVACR systems, each would require a comprehensive evaluation of potential non-PFAS alternatives. At present, there are no non-PFAS alternatives available with the same properties as PTFE. If alternatives can be identified with the required properties for each application, then testing, OEM qualification, supply chain conversion, and codes and standards approvals are all necessary. At least 10 to 15 years estimated to be required for a comprehensive substitution **BUT** depending on the application.	For filters, PTFE provides low pressure drop, low energy consumption, high mechanical stability, high chemical resistance, risk reduction during operation. Fiberglass-based filter media are inferior for pressure drop (energy consumption), mechanical stability and chemical resistance.
	O-rings, seals, washers and gaskets: in compressors, thermal expansion valves **(**TXVs**)**, other system valves, heat exchangers, pumps, filter driers; thrust washers, ball gaskets		More generally PTFE is extremely difficult to replace because of the following properties that are simultaneously present: Low friction, high temperature capability, good low temperature ductility, chemically inert- necessary due refrigerants and refrigerant/lubricant mixtures, compressible bearing surface, ability to transfer to the tribo-counterface and inherent flame retardance and lifetime reliability. See comment on PFAS lubricant derogation
	Bearings and bushings: in compressors and filter driers		
	Diaphragms: in valves		
	Seat plates: in valves		
	Caps: in heat exchangers and valves		
	Grease and oil: in valves		
	Paint: such as silverpaints (important for the function of scratch and weather resistance)		
FEPM (TFE/P) Propylene-tetrafluoroethylene copolymer elastomer	**O-rings, seals**	At least 10 years estimated to be required, for a comprehensive substitution, which includes supply chain conversion, OEM qualification and conversion, and codes and standards approvals	

Table 1. PFAS Fluoropolymers (simplified list)			
PFAS fluoropolymer	**Location in RACHP products (including parts)**	**Approx. timeline for its substitution (in n° of years)**	**Circumstances that justify a REACH derogation** (*see also table 2 for overview summary)*
PFA Perfluoroalkoxy alkane copolymer	**Bearings, O-rings**	At least 10 years estimated to be required, for a comprehensive substitution, which includes supply chain conversion, OEM qualification and conversion, and codes and standards approvals	
FEP Fluorinated ethylene propylene copolymer	**O-rings** **Cables**: for Heating and transmitters **Heating elements**	no timescale estimated	
FKM Vinylidene fluoride-hexafluoropropylene copolymer elastomer	**O-rings, seals, and gaskets**: in compressors, thermal expansion valves **(**TXVs**)**, other system valves, heat exchangers, pumps, filter driers; pressure regulators, sight glasses, switches, transmitters **Diaphragms**: in valves **Seat plates:** in valves	FKM is used for a wide range of applications in HVACR systems, each would require a comprehensive evaluation of potential non-PFAS alternatives. At present, there are no non-PFAS alternatives available with the same properties as FKM. If alternatives can be identified with the required properties for each application, then testing, OEM qualification, supply chain conversion, and codes and standards approvals are all necessary. At least 10 to 15 years estimated to be required for a comprehensive substitution **BUT** depending on the application	FKM is extremely difficult to replace because of the following properties that are simultaneously present: high temperature capability, good low temperature ductility, chemically inert- necessary due refrigerants and refrigerant/lubricant mixtures, inherent flame retardance and lifetime reliability.

Table 1. PFAS Fluoropolymers (simplified list)

PFAS fluoropolymer	**Location in RACHP products (including parts)**	**Approx. timeline for its substitution (in n° of years)**	**Circumstances that justify a REACH derogation** (*see also table 2 for overview summary)*
ETFE Ethylene tetrafluoroethylene copolymer or terpolymer with perfluoro-1-hexene	**Sensor**		
PVDF Polyvinylidene fluoride	**Cables**: Heating **Heating elements**	Substantial time is required for suppliers to develop alternatives	
PFPE Perfluoropolyether (lubricant or grease)	**Valves** - oil, grease	Substantial time is required for suppliers to develop alternatives	PFAS lubricants have a derogation for harsh environments PFPE & PTFE discussed in A.3.15 From Restriction Proposal Documentation E.2.14.2.1. Description of the use and function of the restricted substance(s) "According to stakeholders, PFAS-based lubricants are used in many sectors in situations where they are superior in terms of technical performance under extreme/harsh conditions compared to other lubricants and/or where other types of lubricants would not be technically feasible." The proposed restriction derogation s. lubricants where the use takes place under harsh conditions or the use is needed for safe functioning and safety of equipment until 13.5 years after EIF; appears to be applicable to their use in HVACR.

Table 2 Fluoropolymers: Circumstances that justify a REACH derogation								
	PTFE	**FEPM**	**PFA**	**FEP**	**FKM**	**ETFE**	**PVDF**	**PFPE**
Technical Performance (a combination of some or all of these properties)								
Lifetime Reliability	yes	yes	yes	yes	yes		yes	no
High and/or low temperature performance	yes	yes	yes	yes	yes		yes	yes
Refrigerant/lubricant resistance	yes	yes	yes	yes	yes		yes	no
Electrical Insulation/dielectric performance	yes	yes	yes	yes	yes/no		yes	no
Dimensional stability	yes/no	yes	yes	yes/no	yes		yes/no	no
Other								
Alternatives technical performance								
Key performance limitations	yes	yes	yes	yes	yes		yes	yes
Lack of reliable long term performance information for alternatives	yes	yes	yes	yes	yes		yes	yes
Cost Efficiency								
Technical performance of equipment: e.g. higher power needed if friction increases	yes	yes	yes	yes/no	yes		yes/no	yes
Cost efficiency of components: e.g. if physical design changes needed to compensate for lack of material performance	yes	yes	yes	yes	yes		yes	yes
Safety implications of not using fluoropolymer: e.g. seals etc are critical to prevent leaks and especially relevant to flammable refrigerants	yes/no	yes	yes	yes	yes		yes	no
Survey response explanation: *requested to answer yes or no; yes/no indicates both responses in survey which may reflect different applications within the system, some answers only indicated yes, for some applications/fluoropolymers no additional information provided eg EFTE*								

Table 2: Summarising the main Fluoropolymers and the main functional parameters