Forschungsrat Kältetechnik e.V. (FKT)
Sector: Collective research in the field of refrigeration and heat pump technologies

ECHA application for exemption of PTFE, CAS-Number: 9002-84-0 – English
This application is solely meant for PTFE respective PTFE containing materials. This affects all major components of HVACR (heating, ventilation, air conditioning and refrigeration) systems that are part of the refrigeration cycle or of the control system.

Furthermore, our members are affected with PFAS materials FKM, FFKM, and FEPM.

However, it is nearly impossible to identify all parts affected in the industry with relevant weights.

What is PTFE and why is it considered non-hazardous
The proposal to prohibit PFAS includes the fluoropolymer PTFE, which is of great importance for the refrigeration and heat pump industry.
Fluoropolymers (PTFE) are long chained, harmless and non-toxic for humans and environment, as they do not penetrate in cells, nor do they decompose in smaller, dangerous PFAS molecules.

Safety data sheets per REACH classify therefore PTFE as not hazardous according to Re. 1272/2008, Directive 67/548/EC and Directive 1999/45/EC. The Fluor atom possesses the greatest electronegativity and needs only one electron to reach inert gas status. Therefore, molecule chains are very stable. This „persistence“ represents the negative aspect ECHA is mentioning in the intention to prohibit PFAS, but also the positive properties for the industry (resistance against wear, longevity, chemical and temperature stability).

Function of PTFE materials within the sector and specifically for FKT members
FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points represent the industry in general.

- Refrigeration products are used at low (down to -80°C) and varying temperatures. PTFE is stable at low and varying temperatures.
- PTFE is durable and provides low wear (long lasting). This characteristic is particularly needed for rotating parts (shafts, bushings, bearings, etc). Industrial refrigeration systems are usually operated for at least 20-30 years. During this time, they need to cool reliably and need to be maintained/repaired.
- PTFE provides low friction (low resistance) and good self-lubricating properties. Refrigerant pumps and compressors rotate up to 6000 RPM and for this dynamic load a durable material is needed that at the same time reduces friction to minimize energy consumption and maximize energy efficiency.
- PTFE is chemical resistant and does not change properties when in contact with chemicals. The non-PFAS future-proof refrigerants ammonia, carbon dioxide and hydrocarbons all require suitable sealing materials. PTFE can provide the chemical resistance that is needed.

- PTFE avoids refrigerant gas permeation. This is needed to tightly seal the relevant components against ambient.
- PTFE does not deform at high pressures of more than 120 bar. This property is particularly important for the natural refrigerant carbon dioxide and heat pump applications.
- PTFE has a good form stability and is easy to machine. Therefore, it is well suited for more complex geometries and is used for seal seats in armatures and valves.
- PTFE is a very good dielectric material. This is important for the use in frequency converters to reduce induction voltage. Frequency converters play an important role to improve energy efficiency of the entire refrigeration system.

By introducing alternatives to PTFE for the above applications, components and consequently entire refrigeration systems will have to be re-designed completely. Well-maintained refrigeration systems operate for 20-30 years and longer. In some cases, our members are servicing refrigeration systems that have been operating for 50 years and are still operating today. For these systems already in operation it is necessary to ensure the availability of spare parts containing PTFE for several years or even decades, unless alternatives with the exact same dimensions and properties become available.

Regulations require that refrigerant systems are executed hermetically to improve safety for personnel and environment. Consequently, the residues of parts that wear out over time are not ejected into the environment but remain inside the closed refrigeration cycle.

FKT members' products affected from PTFE

FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points list the affected products of our industrial members.

- Refrigeration systems
- (industrial) heat pumps
- Components
    - All types of compressors for all types of refrigerants and gases
    - Refrigerant pumps
    - Certain heat exchanger applications
    - Armatures, including valves, fittings, and actuation,
    - Installation and sealing material for piping, valves, fittings.
- Refrigerant containers. The entire logistics of refrigerants from production via use to end of life and recycling/reuse is dependent on such containers.

Consumption of PTFE in FKT members' products

Since PTFE is classified non-hazardous, neither CAS number nor weights or percentage of PTFE must be declared in the material safety sheet per REACH. By compliance regulations and personal capacities our association is not able to provide the total amount of PTFE consumed in the products named above. A rough estimate results in ~50 tons of PTFE per year for all FKT member companies. However, it is nearly impossible to identify all parts affected in the industry with relevant weights.

Where are FKT members' affected products needed?
FKT members are manufacturers of refrigeration products, contractors and research institutes.
Refrigeration products are sold to contractors that install refrigeration and heat pump systems for end users.
The export rate varies greatly between FKT members. However, for the manufacturers of refrigeration products the export rate is very high.
The products can be found for example in food production, food and beverage processing, food retail, cold stores, pharmacy, chemical industry, district heating and cooling, domestic and non-domestic buildings.

Processing of PTFE materials at FKT members
The amount of processing PTFE materials varies between our members. Whereas manufacturers of compressors and pumps machine parts made of PTFE, contractors rely on products containing PTFE for new installations or service and do not process the material themselves.
PTFE components of our members' own products are usually delivered as designed and assembled into the products without any further processing. In some cases, (e.g., seal seats) a minimal level of machining is required to ensure dimensions are within tolerances. Additionally, many components from third party suppliers are also containing PTFE sub-components. Generally, employees don't get in contact with harmful particles.

Our members adhere to all relevant accident-prevention and work-safety regulations.

Possible replacement materials used in the past
For the specific properties PTFE is offering there have been no alternative materials available in the past.

Possible alternatives for PTFE
The following potential alternatives have been identified that may be used in the future after an appropriate time for validation and re-designing:

- Circlips can replace PTFE-containing piston pins in compressors, though this requires a change in construction design and will lead to a higher wear and reduced energy efficiency.
- In case of compressors, graphite-coated rings can replace those containing PTFE.
- In limited cases, where the requirements to temperature and chemical stability are not as strict, cable insulations containing PTFE may be replaced with silicone. The timeframe of establishing this potential alternative is in the hands of the suppliers.
- Plain bearings may be replaced with new bearing designs (i.e., roller bearings). The cost of the alternative bearings is expected to increase by a factor of ten, not considering the effort for development, redesign, and laboratory and field testing.
- PEEK is discussed as an alternative for PTFE in some specific applications. but the wide range of applications possible with PTFE will not be covered by PEEK, because of different material properties.

The effort of development, redesign, laboratory, and field testing to establish alternative solutions will come with a significant financial cost. The cost of PTFE-free alternatives is expected to be higher by a factor of 5-10. To remain competitive in non-EU markets it is necessary to pursue a world-wide ban of PTFE.

Required timeframe for possible alternatives
The sole replacement of materials is not possible from our point of view. Instead, entirely new designs will have to be researched. For example, when materials are substituted it is likely that parts and products will have other dimensions and must be newly designed. Also, it may not be possible to meet all requirements from currently active regulations (e.g., leakage rates).

One member reported the example that if bearing materials could be replaced after re-engineering, validation and process alignment will take approx. 3-4 years. It will require about 5 more years once alternative materials have been developed to test and certify new bearings before selling them to end users. All this with the uncertainty whether results of extensive field testing will ensure similar service life.

Also, there are necessary prerequisites for the development or the success of alternatives. Customers must accept the mitigated performance of alternatives, the availability of spare parts has to be guaranteed for facilities already in operation, and the requirements of national and European regulation must be met.

Components and facilities already in operation will require spare parts for the next 20-30 years and longer. To ensure this supply is essential not only for the reputation of our members but also for the un-interrupted functioning of the cold chain.

To fulfil environment and work-place safety it is mandatory to comply with the relevant local and EU regulations. Only if certain compromises regarding safety and environment pollution become acceptable it becomes possible to look into other material options. On European level it is necessary to agree to binding rules (particularly regarding warranty and liability issues).

Even when the first attempts for alternatives are immediately successful, it will take at least 6 years from start to introduction at the customer site. However, realistically 8-9 years are needed.

Our members would not be able to allocate sufficient resources to investigate possible alternatives for all parts and components containing PTFE used today.

Cost for PTFE alternatives
The overall costs of alternatives are difficult to predict as they depend on the duration of the re-design process, standards that must be met, necessary modifications to testing stations, and how suitable the proposed alternative turns out to be (if at all).

The cost for alternatives cannot be estimated at this point.

Recycling/re-use
Since PTFE is very durable there is only little waste during maintenance/repairs. Since maintenance and repairs are only executed by educated professionals (in compliance with the regulations), appropriate disposal is ensured.

A concept to re-use PTFE materials should be possible. Suppliers have confirmed that treatment for reuse should be feasible due to the “persistence”.

Socio-economic consequences when PTFE is prohibited
In case of a short or mid-term ban of PTFE, higher leakage rates and faster wear need to be accepted by the customers as well as policy makers due to missing alternatives. Even where alternatives can be found the economic performance is likely going to be mitigated as energy efficiency would be reduced and operating cost would go up. In addition, an increased energy consumption leads to higher secondary emissions, e.g., CO_2 emissions related to the generation of electricity.

Without clear standards set by the EU the research for alternatives will fail, or the corporate risk becomes very high and could result in insolvencies of companies that were considered stable until today.

High temperature and high-pressure applications become more common with the use of excessive industrial heat for heat pumps, also for communal heating. These new technologies are key to reduce CO_2 emissions and to achieve climate targets. Investigations are taking more natural refrigerants into account.

We can identify the following main consequences:

- higher risk of health and environment exposures to leaking refrigerants (PFAS as well as non-PFAS),
- reduction in the quality of life (interrupted cold chain, availability of heat pump technology),
- delay or prevention of the “Green deal” goals,
- higher emissions of harmful substances (i.e., refrigerant oils),
- loss of competitiveness (performance, market share, copied spare parts by third parties)

For industrial companies within the EU a fair worldwide competition is essential. Prohibiting PTFE materials will endanger an industry that today is technical market leader.

Several thousand workplaces at our member companies are endangered.

We herewith apply for an exemption of PTFE from the intended PFAS prohibition.

The following members have been mandated to speak on behalf of FKT regarding the information on PTFE presented above:

- TH. WITT Kältemaschinenfabrik
- GEA Refrigeration Technologies GmbH
- Johnson Controls Systems & Service GmbH
- TEGA - Technische Gase und Gasetechnik GmbH

Overview of affected components and products at FKT members

Substance	area of use	affected component	affected product	reason for use	alternative solution	consequences
PTFE (CAS-No.: 9002-84-0)	Construction and coating material	Washers, bearings, shaft seals, bushings, valves, membranes, tubing	all major components of HVACR systems	thermal resistance down to -80 °C, form stability above pressures of 120 bar, low wear, low friction, machinability	None with required properties	functionality not longer given, increased wear, increased servicing and operating cost; Spare parts can no longer be supplied. Plants with a long life time have to be shut down before end of life; unacceptable leakage rates in violation of safety standards; as systems' performance decreases, competitivity of manufacturers and customers decrease as well; the workplaces of thousands of employees at our member companies are at risk
	Construction and coating material	bearings	pumps and compressors	thermal resistance down to -80 °C, form stability above pressures of 120 bar, low wear, low friction, machinability	roller bearings	testing and validation necessary; increased wear, increased servicing and operating cost; Spare parts can no longer be supplied. Plants with a long life time have to be shut down before end of life; as systems' performance decreases, competitivity of manufacturers and customers decrease as well;
	Gaskets and sealing systems	O-rings, packed glands, sealing systems, safety valves, heat exchangers,	all major components of HVACR systems	thermal resistance down to -80 °C, chemical resistance to refrigerants and lubricants, form stability above pressures of 120 bar, low wear, low friction, avoids gas permeation	None with required properties	functionality not longer given, increased wear, increased servicing and operating cost; Spare parts can no longer be supplied. Plants with a long life time have to be shut down before end of life; unacceptable leakage rates in violation of safety standards; as systems' performance decreases, competitivity of manufacturers and customers decrease as well; the workplaces of thousands of employees at our member companies are at risk
	Gaskets and sealing systems	piston pins	compressors for all types of refrigerants	thermal resistance down to -80 °C, form stability above pressures of 120 bar, low wear, low friction, machinability	circlips	testing and validation necessary; increased wear, increased servicing and operating cost; Spare parts can no longer be supplied. Plants with a long life time have to be shut down before end of life; as systems' performance decreases, competitivity of manufacturers and customers decrease as well;
	Gaskets and sealing systems	PTFE-coated sealing rings	compressors for all types of refrigerants	thermal resistance down to -80 °C, chemical resistance to refrigerants and lubricants, form stability above pressures of 120 bar, low wear, low friction, avoids gas permeation	graphite-coated rings	testing and validation necessary; otherwise little consequences; Spare parts can no longer be supplied. Plants with a long life time have to be shut down before end of life
	Gaskets and sealing systems	Sealings of refrigerant containers	indirect	unknown	unknown	The entire logistics of refrigerants from production via use to recycling/reuse/destruction at end of life depends on the availability of refrigerant containers.
	Electrotechnical and electrical components	cable insulation	electrically powered components of HVACR systems, i.e., motors, sensors, control system, etc.	thermal resistance, long lasting, machinability	insulation made of silicone	lower chemical stability; only feasible in certain cases
	Electrotechnical and electrical components	electric control systems	frequency converters in compressors and pumps	dielectric properties	unknown	increased induction voltage in compressors and pumps, non-optimal operation, reduced energy efficiency during operation

An estimated amount in the order of **~50 tons of PTFE per year** are used by FKT members.

Forschungsrat Kältetechnik e.V. (FKT)
Sector: Collective research in the field of refrigeration and heat pump technologies

ECHA application for exemption of FKM, CAS-Number: 64706-30-5 and FFKM, CAS-Number: 26425-79-6 – English

This application is meant for FKM/FFKM respective FKM/FFKM containing materials. This affects sealings and O-rings of heat pump systems which are exposed to high temperature, high pressure, natural refrigerants (e.g., Ammonia, hydrocarbons, etc.) and respective lubricants.

Furthermore, we are affected with PFAS materials PTFE and FEPM.

What is FKM/FFKM and why is it considered non-hazardous

The proposal to prohibit PFAS includes the fluororubber FKM and perfluoro rubber FFKM which are of importance for the sealing systems in some refrigeration and heat pump industry applications.

FKM (Fluoroelastomers) are a family of fluoroelastomer materials consisting of vinylidene fluoride (VDF) as a monomer combined with a variety of other fluoromonomers to create a palette of polymers with properties tailored for specific uses (Korzeniowski, 2023).

FKM fluoroelastomers are used mainly in fabricated parts (e.g., O-rings, gaskets, seals) to provide barriers against a wide range of fluids under severe service conditions. Their design allows stable extrusion and moulding processes and fitting in a wide range of processing constraints, reducing the risk of failure and increasing productivity. FKM fluoroelastomers provide high temperature and aggressive fluids resistance and retention of properties over a wide and demanding range of operating use conditions (high and low temperatures) for sealing and fluid transport applications, offering far superior performance than hydrocarbon elastomers (Korzeniowski, 2023).

Perfluoroelastomers (FFKM) are a fully fluorinated class of elastomers that are typically made up of tetrafluoroethylene (TFE), a perfluoro (alkyl vinyl ether; PAVE), and a cure site monomer(s). FFKM elastomers offer superior chemical and temperature resistance, excellent resistance to gas and liquid permeation, and resistance to weather and ozone with operating temperatures ranging from −40 °C to 325 °C (Korzeniowski, 2023).

FKM and FFKM both meet the OECD polymer of low concern criteria (Korzeniowski, 2023).

Function of FKM/FFKM materials within the sector and specifically for FKT members

FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points represent the industry in general.

- FKM/FFKM sealings and O-rings in compressors, bearings, fittings, valves, and armatures of heat pump systems which are exposed to high temperature, high pressure, natural refrigerants (e.g., NH_3, R-1270), and respective

lubricants, where FEPM and other materials are not meeting the requirements. Tightness and integrity of heat pump and refrigeration systems are key for system efficiency and the safety of assets, humans and the environment and must be ensured over the lifetime of the systems.

- FKM/FFKM gaskets and sealing systems are elemental parts of leak detectors where their extremely low and stable gas permeation ensures a high detector sensitivity. E.g., the various detector components must be tightly sealed against ambient to ensure that a high vacuum can be generated and sustained at a small and constant rate of degassing. Well-functioning leak detectors are required for ensuring the tightness of the refrigeration cycle at manufacturing, installation, servicing, and the regularly performed leakage tests required by regulations. For example, the standard DIN 8964-2:2002 demands for the refrigerant R600a used in refrigerating cabinets a detection limit of 0,5 g/a. The use of a less tight sealing material will result in a background through constant degassing >0,5 g/a. Consequently, a leak detection in conformity with safety regulations will not be met any longer. This directly affects refrigeration and heat pump systems concerning state-of-the-art safety measures and loss of refrigerant prevention.

Well-maintained refrigeration and heat pump systems operate for 20-30 years and longer. For these systems already in operation it is necessary to ensure the availability of spare parts containing FKM/FFKM or substitutes with the exact same dimensions and properties.

Regulations require that heat pump and refrigerant systems are executed hermetically to ensure safety for personnel and environment. Consequently, the residues of parts that wear out over time are not ejected into the environment but remain inside the closed refrigeration cycle.

FKT members' products affected from FKM/FFKM

FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points list the affected products of our industrial members.

- Heat pump systems,
- Compressors for high pressure and temperature applications in other industry segments,
- Armatures, including valves and fittings,
- Actuators and sensors to control heat pump systems and some refrigeration systems,
- Leak detectors.

Consumption of FFKM in FKT members' products

By compliance regulations and personal capacities our association is not able to provide the total amount of FFKM consumed in the products named above.
A number in the order of 10-100 sealings will be required per system with an estimated weight of 0.1-10 kg. The number of affected systems is difficult to be estimated and we are not able to make a justified estimate.

Where are FKT members' affected products needed?

The products can be found in commercial and industrial heating and refrigeration. Heat pumps are becoming more and more important in the industry to use excessive heat from and in industrial processes and district heating. This technology offers unique potential to reduce the consumption of fossil energy.

Processing of FKM/FFKM materials at FKT members
In general, FKM/FFKM materials are not processed by our members, but purchased in ready-made sealings, O-rings, gaskets, or as sealings in mechanical third party components (e.g., bearings, etc.).

Possible replacement materials used in the past
The development of heat pumps with increasing pressure and temperature needs to support by the availability of suitable sealing materials. Sealing materials used in refrigeration systems, e.g., CR or HNBR have not been tested suitable in these conditions. FKM/FFKM can be used under conditions which also exceed these suitable for FEPM.

Possible alternatives for FKM/FFKM
We are not aware of alternatives outside of the PFAS group. In the development of heat pumps, alternative natural refrigerants, and future applications we are in close contact with the sealing industry. FKM/FFKM can be used under conditions which also exceed these suitable for FEPM which makes it important in the research and development of future products and applications.

Alternatives with lower performance in terms of chemical, temperature and mechanical resistance would not be acceptable. These would compromise safety, and lead to unacceptable leakage rates, increased maintenance costs due to deterioration and wear and overall increased operating costs and down-time.

To remain competitive in non-EU markets it is necessary to pursue a world-wide ban of FKM/FFKM.

Required timeframe for possible alternatives
This needs to be addressed by the sealing industry. Once alternatives are available, our members consider approx. 5 years for redesign, laboratory, and field testing.

Cost for FKM/FFKM alternatives
At this point an estimation of costs is not possible on the FKT level, because too many parties are involved. It also depends on the amount of re-design required, based on the alternative material properties.

Recycling/re-use
In our applications FKM/FFKM is used in a closed cycle and the wear of the material is minimal to zero. Any particles would be collected in system filtration and could not get into the environment.
Today, FKM/FFKM Sealings are usually disposed after their service with communal trash since they are considered as polymers of low concern and only exist in small amounts. However, in the future they could be collected separately. For some PFAS recycling concepts already exist (e.g., PTFE). We are not aware if these concepts exist for FFKM.

Socio-economic consequences when FKM/FFKM is prohibited

The heat pump business is an important growth market for our members, an important contributor for the EU's machinery industry and secures thousands of workplaces today and even more so in the future.

The green deal and efforts to reduce the consumption of fossil energy and CO_2 emissions is highly depending on various heat pump applications in many industries and for heating. The industry needs to be flexible over a wide range of temperatures and pressures as well as alternative refrigerants, to find an optimum of efficiency within that respective process.

Without FKM/FFKM many heat pump applications would not be feasible due to a lack of an alternative and respective projects would need to be put on-hold.

We herewith apply for an exemption of FKM/FFKM from the intended PFAS prohibition.

The following members have been mandated to speak on behalf of FKT regarding the information on FKM/FFKM presented above:

- GEA Refrigeration Technologies GmbH
- Johnson Controls Systems & Service GmbH

References:
S. H. Korzeniowski et al., *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers,* Integr Environ Assess Manag, **2023:326–354**, DOI: 10.1002/ieam.4646

Overview of affected components and products at FKT members

Substance	area of use	affected component	affected product	reason for use	alternative solution	consequences
FKM (CAS-No.: 64706-30-5)	Gaskets and sealing systems	O-rings and other sealings in compressors, bearings, fittings, valves, and armatures	heat pump systems, compressors for high pressure and high temperature applications	high temperature resistance, high pressure resistance, chemical resistance to refrigerants R-717, R-1270, and respective lubricants	Not with required properties	increased wear, increased servicing and operating cost, reduced temperature stability, reduced chemical stability, compromised safety, unacceptable leakage rates; Spare parts can no onger be supplied. Plants with a long life time have to be shut down before end of life.
	Gaskets and sealing systems	sealing components in leakage detectors	leak detectors	low, stable gas permeation	Not with required degassing <0,5 g/a	background signal due to degassing >0,5 g/a; leak tests do not meet sensitivity requirements; compromised safety against refrigerant leakage.
	Electrotechnical equipment	Actuators, sensors in control systems	heat pump systems and some refrigeration systems	high pressure resistance, chemical resistance to refrigerants R-717, R-1270,	Not with required properties	increased wear, increased servicing cost, increased operating cost due to non-optimal system control, reduced system efficiency, reduced temperature stability, reduced chemical stability; Spare parts can no onger be supplied. Plants with a long life time have to be shut down before end of life.
FFKM (CAS-No.: 26425-79-6)	Gaskets and sealing systems	sealing components in leakage detectors	leak detectors	low, stable gas permeation	Not with required degassing <0,5 g/a	background signal due to degassing >0,5 g/a; leak tests do not meet sensitivity requirements; compromised safety against refrigerant leakage.

An estimated amount in the order of **up to 10 kg of FKM/FFKM per HVACR system** is used.

Forschungsrat Kältetechnik e.V. (FKT)
Sector: Collective research in the field of refrigeration and heat pump technologies

ECHA application for exemption of FEPM (TFE/P), CAS-Number: 27029-05-6 – English

This application is solely meant for FEPM respective FEPM containing materials. This affects sealings and O-rings of heat pump systems and some refrigeration systems which are exposed to high temperature, high pressure, natural refrigerants (e.g., Ammonia, hydrocarbons) and respective lubricants.

Furthermore, our members are affected with PFAS materials PTFE, FKM, and FFKM.

What is FEPM and why is it considered non-hazardous

The proposal to prohibit PFAS includes FEPM which is of great importance for the refrigeration and heat pump industry.

Trifluoroethylene-propylene copolymer (FEPM) elastomers are fluoropolymers with alternating tetrafluoroethylene and propylene segments. They are also known as TFE-P copolymers (Korzeniowski, 2023).

FEPM elastomers provide exceptional heat resistance with a continuous service temperature higher than 200°C, outstanding chemical resistance with little or no deterioration even in contact with strong acids, bases, and oxidants at high temperatures. FEPM elastomers are also used in high-performance wire and cable applications as insulating materials with the highest heat resistance (Korzeniowski, 2023).

FEPM meets the OECD polymer of low concern criteria (Korzeniowski, 2023).

Function of FEPM materials within the sector and specifically for FKT members

FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points represent the industry in general.

- Sealings and O-rings in compressors, bearings, fittings, valves, and armatures of heat pump systems which are exposed to high temperature, high pressure, natural refrigerants (i.e., Ammonia, hydrocarbons) and respective lubricants.
- Tightness and integrity of heat pump and refrigeration systems are key for system efficiency and the safety of assets, humans and the environment and must be ensured over the lifetime of the systems.

Well-maintained heat pump systems are designed to operate for 20-30 years and longer. For these systems already in operation it is necessary to ensure the availability of spare parts containing FEPM or substitutes with the exact same dimensions and properties.

Regulations require that heat pump and refrigeration systems are executed hermetically to ensure safety for personnel and environment. Consequently, the residues of parts that wear out over time are not ejected into the environment but remain inside the closed refrigeration cycle.

FKT members' products affected from FEPM
FKT is a non-producing, non-profit association of industrial and non-industrial partners of the refrigeration and heat pump industry. The following points list the affected products of our industrial members.

- Heat pump systems,
- Organic Rankine Cycle systems,
- Compressors for high pressure and temperature applications in other industry segments, e.g., open cycle gas compression, armatures including valves and fittings,
- Actuators and sensors to control heat pump and some refrigeration systems.

Consumption of FEPM in FKT members' products
By compliance regulations and personal capacities our association is not able to provide the total amount of FEPM consumed in the products named above.
As a guideline, a number in the order of 10-100 sealings will be required per system with an estimated total weight of 0.1-10 kg. For the number of systems a justified estimate cannot be made by FKT.

Where are FKT members' affected products needed?
The products can be found in commercial and industrial heating and refrigeration. Heat pumps are becoming more and more important in the industry to use excessive heat from and in industrial processes and district heating. This technology offers unique potential to reduce the consumption of fossil energy.

Processing of FEPM materials at FKT members
In general, FEPM materials are not processed by our members, but purchased in ready-made sealings and O-rings, or as sealings in mechanical third-party components (e.g., bearings, etc.).

Possible replacement materials used in the past
The development of heat pumps with increasing pressure and temperature was supported by the availability of suitable sealing materials. Sealing materials used in refrigeration systems, e.g., CR or HNBR have not been tested suitable in these conditions.

Possible alternatives for FEPM
We are not aware of alternatives outside of the PFAS group. In the development of heat pumps, alternative natural refrigerants, and future applications we are in close contact with the sealing industry. Another material for sealings and O-rings in even higher temperature conditions is the PFAS FFKM.

The sole replacement of materials is not possible from our point of view, because alternatives are only possible with entirely new designs (due to i.e., other dimensions) and will likely not be able to meet requirements from currently active regulations (e.g., leakage rates).

Alternatives with lower performance in terms of chemical, temperature and mechanical resistance would not be acceptable. These would compromise safety, and lead to unacceptable leakage rates, increased maintenance costs due to deterioration and wear and overall increased operating costs and down-time.

The effort of development, redesign, laboratory, and field testing to establish alternative solutions will come with a significant financial cost. To remain competitive in non-EU markets it is necessary to pursue a world-wide ban of FEPM.

Required timeframe for possible alternatives
This needs to be addressed by the sealing industry. Once alternatives are available, our members consider approx. 5 years for redesign, laboratory, and field testing.

Cost for FEPM alternatives
At this point an estimation of costs is not possible on the FKT level, because too many parties are involved. It also depends on the amount of re-design required, based on the alternative material properties.

Recycling/re-use
In our members' applications FEPM is used in a closed cycle and the wear of the material is minimal to zero. Any particles would be collected in system filtration and could not get into the environment.
Today, FEPM sealings are usually disposed after their service with communal trash since they are considered as polymers of low concern and only exist in small amounts. However, in the future they could be collected separately. For some PFAS recycling concepts already exist (i.e., PTFE). We are not aware whether these concepts exist for FEPM.

Socio-economic consequences when FEPM is prohibited
The heat pump business is an important growth market for our members, an important contributor for the EU's machinery industry and secures thousands of workplaces today and even more so in the future.

The green deal and efforts to reduce the consumption of fossil energy and CO_2 emissions is highly depending on various heat pump applications in many industries and for heating. The industry needs to be flexible over a wide range of temperatures and pressures as well as alternative refrigerants, to find an optimum of efficiency and safety within that respective process.

Without FEPM many heat pump applications would not be feasible due to a lack of an alternative and respective projects would need to be put on-hold.

We herewith apply for an exemption of FEPM from the intended PFAS prohibition.
The following members have been mandated to speak on behalf of FKT regarding the information on FEPM presented above:

- GEA Refrigeration Technologies GmbH

References:
S. H. Korzeniowski et al., *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers,* Integr Environ Assess Manag, **2023:326–354**, DOI: 10.1002/ieam.4646

Overview of affected components and products at FKT members

Substance	area of use	affected component	affected product	reason for use	alternative solution	consequences
FEPM (TFE/P)	Gaskets and sealing systems	O-rings and other sealings in compressors, bearings, fittings, valves, and armatures	heat pump systems, Organic Rankine Cycle systems, compressors for high pressure and high temperature applications	high temperature resistance, high pressure resistance, chemical resistance to natural refrigerants (i.e., Ammonia, hydrocarbons) and respective lubricants	PFAS-free sealings	increased wear, increased servicing and operating cost, reduced temperature stability, reduced chemical stability, compromised safety, unacceptable leakage rates; Spare parts can no onger be supplied. Plants with a long life time have to be shut down before end of life.
	Electrotechnical equipment	Actuators, sensors in control systems	heat pump systems and some refrigeration systems	high temperature resistance, high pressure resistance, chemical resistance to refrigerants R-717, R-1270, and respective lubricants	Not with required properties	increased wear, increased servicing cost, increased operating cost due to non-optimal system control, reduced system efficiency, reduced temperature stability, reduced chemical stability; Spare parts can no onger be supplied. Plants with a long life time have to be shut down before end of life.

An estimated amount in the order of **up to 10 kg of FEPM per HVACR system** is used.