VOLKSWAGEN

AKTIENGESELLSCHAFT

Statement of Volkswagen Group on PFAS Restriction Proposal

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Content

1. Executive Summary

Volkswagen Group appreciates the opportunity to comment on the actual PFAS restriction proposal. Taking into consideration the huge variety of use case and substances under discussion, we are focusing our comments on the following topics of our major concern:

- **Fluoropolymers**
  The scope of the restriction should be limited to PFAS posing a risk to health or the environment. Fluoropolymers which are to be considered as polymers of low concern should be excluded from the restriction. Volkswagen Group calls for a return to a risk- and substance-based approach to restrictions. (see chapter 3.1)

- **Batteries**
  Batteries are key for transforming the transport sector. To secure this transformation exemptions are required for applications for the production of lithium-ion batteries for transport vehicles e.g., binder for the coatings of the electrodes or additives for electrolytes. Currently no substitute is available – neither in pre-development nor any level of industrial scale- to replace the commonly used PFAS-substances in batteries. Additionally exemptions should be given for batteries for energy storage systems or transport vehicles for repurpose use e.g., as energy storage devices. (see chapter 3.2)

- **Electronics**
  Within the restriction proposal some exemptions are proposed but based on our assessment these exemptions are inadequate and do not consider the significance of PFAS related to functional requirements in multiple applications and potential innovations in the electronics and digital industry.
  General and extended derogations are essential, particularly when no technically appropriate and environmentally safer alternatives are available.
  The dossier submitter did not propose a derogation for PFAS in electronics. Volkswagen Group proposes to add a derogation for electrical and electronic components for 13.5 years. (see chapter 3.3)

- **Seals and hoses**
  Seals and hoses containing PFAS polymers of low concern shall be exempted from the restriction proposal. Seals and hoses where the use takes place under highly demanding conditions or where the use is needed for proper and safe functioning or safety of equipment shall be exempted from the restriction proposal. (see chapter 3.4)

- **Lubricants**
  PFAS-containing lubricants shall not be prohibited for use cases under harsh conditions or where the implementation of safety-related functions is required. (see chapter 3.5)

- **Metal Plating**
  The use of PFAS plays an important role within hard chrome plating processes as mist suppressant to secure and increase workers safety. Nowadays no PFAS-free technically

suitable substitutes are available to ensure a safe hard chrome plating process. To ensure an implementation of suitable, PFAS-free alternatives, Volkswagen Group proposes a derogation period of 13,5 years. (see chapter 3.6)

- **Production**
  A responsible use of machineries and equipment which contain PFAS for the manufacturing process of parts and vehicles should be possible in the future. This means, that the maintenance and repair of these machineries and components should be exempted as repair is more beneficial than replacement. In order to be able to repair existing machines, a derogation for the process aids, such as refrigerants for refilling of HVACR equipment, is necessary in addition to a derogation for machine parts.
  Furthermore the trading of used machines and systems must continue to be possible without restrictions. The value of these machines and production systems is very high and further reuse is more beneficial than decommissioning. (see chapter 3.7)

- **Refrigerants**
  Due to the relatively high amount of PFAS contained in the refrigerant of actual mobile air conditioning system and the fact that small amounts of refrigerant are released into the environment even during regular operation over lifetime, the refrigerant offers significant leverage for the effective reduction of PFAS.

  Consequently, VW Group is working to convert all **BEV models** to the refrigerant R744. The market introduction of first new BEV platforms using R744-only will start during the second half of this decade and the overall transformation towards R744 takes several years until end of 2030 to change all major BEV-platforms. Only for limited sales volume based on old BEV-platforms we recommend to offer an additional time before end of production. (see chapter 4.2.1)

  Regarding all **ICE cars (incl. hybrids)** the VW Group highly suggests an exemption of the PFAS restrictions. Focusing the limited development capacities on BEV-only secures a fast transition in these future related purely EV-models. Applying PFAS restrictions in addition to the diminishing volume of ICE would endanger improving the BEV-platforms, add huge complexity into development processes and overburden limited development capacities in industry. (see chapter 4.2.2)

  Vehicles for export and **vehicles for testing** during development and pre-production phase are to be permanently excluded from the restriction , even after PFAS-based refrigerants are prohibited for use in new cars in Europe. (see chapter 4.3)

- **Used car trade and customer service**
  Used car trade and spare parts for customer service shall be exempted from the restriction proposal. Replacing of used cars or used car parts on the market (purchase and sale) must remain permanently permitted according to the ‘repair as produced’ principle, which is widely accepted in the European Union .The possibility of remarketing of used vehicles, machines and their parts is of decisive importance in view of the European waste hierarchy. For example refrigerants: The repair and refilling of vehicles on the market with original refrigerant must remain permanently possible in the EU. Customer service of MAC systems must always remain possible.

2. Preliminary Remarks

The Volkswagen Group fully supports the sustainability goals of the German government and the European Union and the associated protection of air, water and soil.

The Volkswagen Group is therefore committed to continuously reduce environmental impact of the whole value chain and in this case, the responsible and differentiated handling of the various PFAS when used in vehicles.

The Volkswagen Group is focusing on development and investments in the direction of electrification of the entire fleet and model portfolio. This transformation to climate-neutral mobility by 2050 is irreversible for the Volkswagen Group. By 2030, the share of all-electric new cars in Europe is expected to be around 70 percent, CEO Oliver Blume recently told to “Handelsblatt”.

Against this background, the comprehensive restriction proposal - especially in the central components of electric drives - is viewed with great concern.

The complete and accelerated transition to electromobility requires exceptional investments by our Group and a clear focus of resources and development capacities. This restriction proposal, which is tantamount to a quasi-ban, would require a not feasible re-engineering of an extremely large number of components and assemblies of today's vehicles and tie up far-reaching human and economic resources in an extremely limited timeframe. The necessary and desired transformation to electromobility would be at least drastically delayed and endangered.

For today's vehicle concepts - especially with regard to electromobility - the use of PFAS is indispensable. However, emissions into the environment can be largely excluded through responsible use.

The comprehensive PFAS restriction proposal currently under discussion entails economic risks for the entire industry that could be avoided, as the proposal currently also includes the restriction of non-substitutable PFAS and PFAS classified as safe.

The chemical substance group of PFAS ranges from gases to polymers with greatly varying classifications in terms of risks to the environment and public health. Based on the aforementioned differentiation, it is not justified to classify all PFAS substances in one homogeneous substance group of PFAS – as assumed in the restriction proposal.

Due to their unique characteristics, PFAS are utilized in the automotive industry: from lithium-ion accumulators to electronics, elastomers, lubricants and means in tire production processes.

The vast majority of PFAS parts used in the automotive industry are made of fluoropolymers which are classified by the OECD as ‘polymers of low concern’ (PLC), as they do not lead to a

hazardous risk for human health and the environment. However, despite the classification as PLCs, these fluoropolymers are intended to become subject to the extensive restriction with regard to manufacture, placing on the market and use by the present restriction proposal. Volkswagen Group calls for general derogation of fluoropolymers, which are PLC, from the restriction of PFAS.

PFAS for which there are currently no substitutes, must be allowed to continue to be used temporarily until a technically adequate and economically viable alternative is available.

Volkswagen Group is continuously working to minimize the environmental impact of PFAS and – in the case of those considered hazardous – to switch as quickly as possible if a substitute is available for series production and if it is economically feasible. The prerequisite for such a changeover is always the availability of an adequate replacement and a sufficient changeover time. Due to this PFAS, such as 2,3,3,3-tetrafluoropropene (R1234yf) which is used as refrigerant in mobile air conditioning systems, will be replaced by R744 with great efforts in a timely feasible approach.

Without changes to the proposed restriction, in particular the proposed content and regulatory timelines, significant production losses in Europe are inevitable due to a lack of development times and substitutes.

In addition, the present restriction proposal would almost completely end vehicle exports from the EU. Vehicles manufactured in the EU would have to comply with PFAS regulations and use potentially more expensive substitutes (e.g. R744). Competitors from other non-EU regions would not have this restriction and could therefore achieve significant cost advantages. At the same time, the used car market and the repair of today's existing vehicles would be banned, since an upgrade of existing cars to R744 is not possible. The massive economic impact would affect all European plants and all manufacturers.

At this point, it is emphasized that Volkswagen Group fully supports the statements made on the 30th of August 2023 by VDA. Volkswagen Group also favors the VDA's reasonable, responsible, sophisticated and risk-balanced 5-step approach towards PFAS.

In particular, Volkswagen Group supports the general comments made by the VDA on the scope of the restriction with regard to Fluoropolymers.

In addition, Volkswagen Group would like to highlight certain topics in accordance with the VDA position in this statement. (see chapter 3)

With regard to PFAS-containing gas Volkswagen Group’s point of view differentiates from the positions of associations VDA and ACEA. Volkswagen Group is proposing a different and earlier phase out for the F-gas refrigerant in MAC systems as we here see a key for effective PFAS reduction. (see chapter 4)

3. Amendments for specific applications of PFAS

This chapter discusses important specific applications for PFAS-containing materials for Volkswagen Group and proposes appropriate restriction recommendations.

3.1. General remarks on the regulation of fluoropolymers

The proposed restriction comprises lots of fluoropolymers, such as PTFE or PVDF, which are classified as 'polymers of low concern' according to the criteria of the OECD. OECD points out that 'the term PFAS is a broad, general, non-specific term, which does not inform whether a compound is harmful or not'[1]. Fluoropolymers which are classified as PLCs are not considered a hazard for public health or the environment. That means those PLCs do not meet the requirements defined by Article 68 (1) of the REACH regulation as empowering statute.

A scientific study[2] addressing blanket risk assessment of PFAS concludes that '*all PFAS should not be grouped together, persistence alone is not sufficient for grouping PFAS for the purposes of assessing human health risk, and that the definition of appropriate subgroups can only be defined on a case-by-case manner*'.

Another study[3] about the fluoropolymers PTFE, ETFE, FEP and PFA illustrates that these substances are to be regarded as immobile, unable to be accumulated biologically, water-insoluble, and not toxic. The evaluation showed that there are small residual amounts of monomers in the common fluoropolymers under consideration, which do not lead to an increase in hazardousness.

Furthermore, there is a study[4] showcasing that lots of fluoropolymers, such as PVDF and FKM, meet the PLC criteria implicating that utilizing them does not raise expectations of impact on public health or the environment.

Assessment of emissions of fluoropolymers
Several national and EU legislations set strict limit values and environmental standards, such as the European Union's Industrial Emissions Directive (IED) which effectively regulates emissions during the manufacture of fluoropolymers. From our point of view, the fluoropolymer industry is one of the most monitored industries in terms of environment and emissions.
Additionally the manufacturers of fluoropolymers continue investigating and developing R&D programs for the advancement of technologies allowing for a full transition away from using PFAS-based polymerization aids during fluoropolymer production.

During the appropriate production and use of vehicles no emission of fluoropolymers into the environment does occur. A low possibility of release is limited to malfunctions and accidents.

Components containing PFAS are also handled properly in the recycling phase. They are either properly disposed of and reprocessed, reused (e.g., as used spare parts) or completely decomposed due to the high temperatures in the thermal incinerators. The resulting fluorine compounds are removed via gas scrubbers.[5)]

In addition, a chemical approach is implemented in the first known pilot plant that can close the product cycle of the chemicals via upcycling. In this process, they are decomposed into gaseous monomers via pyrolysis. These can then be captured, purified and reused for the production of new polymers without any loss of quality.[6)]

The blanket restriction of fluoropolymers is unjustified due to the classification as PLCs and the fact that normally no fluoropolymers or their fluorinated degradation products are emitted into the environment during their manufacture, utilization and energetic recovery. Furthermore, the persistence of many fluoropolymers does not justify the classification as SVHC and therefor a possible restriction, as these fluoropolymers are neither toxic, nor mobile, nor bioaccumulable.

Conclusion and proposed amendment
The restriction should be limited to PFAS posing a risk to health or the environment. Fluoropolymers which are to be considered as polymers of low concern should be excluded from the restriction. Volkswagen Group calls for a return to a risk- and substance-based approach for the restriction of PFAS.

[1]) see OECD Publication: Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance Series on Risk Management No.61, 09.07.21

[2]) "Grouping of PFAS for human health risk assessment: Findings from an independent panel of experts" J.K. Anderson et al., Regulatory Toxicology and Pharmacology, 2022

[3]) " A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers", Barbara J Henry et.al., 2017, Integrated Environmental Assessment and Management — Volume 14, Number 3—pp. 316–334

[4]) "A Critical Review of the Application of Polymer of Low Concern Regulatory Criteria to Fluoropolymers II: Fluoroplastics and Fluoroelastomers" S. H. Korzeniowski et.al., Integrated Environmental Assessment and Management · June 2022

[5]) Gehrmann et al. (2023): Pilot-Scale Fluoropolymer Incineration Study: Thermal Treatment of a Mixture of Fluoro-polymers under Representative European Municipal Waste Combustor Conditions

[6]) https://www.chemanager-online.com/news/cycling-von-vollfluorierten-polymeren (last access: 24.05.2023)

3.2. Batteries

Use case and significance
One of the main and strategic and environmentally relevant applications of PFAS at Volkswagen Group is in batteries: the use of PVDF as a cathode binder in lithium-ion batteries. All binders used in series production today consist of the fluoropolymer PVDF regardless of the metal oxide (NMC, LFP) used. In addition to traction batteries, starter batteries can also be affected in the event of a lead ban. In today´s LIB 15 – 50 g PVDF per kWh are used, depending on the power of the battery. In addition, there are other relevant applications of PFAS at cell, module and system level, especially as a sealing material.

New, dry electrode coating processes that are conceivable in the future for solid-state batteries also require fluoropolymers (e.g. PTFE).

According to the current state of research, sodium-based batteries, which could possibly play a role in the future, also require PFAS-containing binders.

Currently, there are no alternative materials foreseeable that meet the demanding requirements of a LIB cathode in terms of mechanical, thermal and electrochemical properties as fluoropolymers such as PVDF and PTFE.

In the future, solid-state batteries may become available using a polymeric electrolyte instead of today's liquid electrolyte. In order to ensure the performance of these batteries, it is likely that PFAS-containing electrolytes, e.g. LiTFSI, are required for this future technology, too.

Conclusion and proposed amendment
Battery technology is the key lever for EU green deal realization. A ban on fluoropolymers for the production of lithium-ion batteries prevents the successful introduction of electromobility and thus the achievement of the goals of the EU green deal.

Volkswagen Group is currently investing large sums of money to set up battery production at several plants in Europe (e.g. Spain, Germany, Sweden) to reduce the dependence on Asian producers. A ban on PFAS would jeopardize the commission's objectives to strengthen resilience of the European economy.

PVDF or PTFE are classified as polymers of low concern according to OECD criteria and should be removed from the scope of the restriction (see section 3.1). Furthermore, fluoropolymers such as PVDF are relatively expensive materials and are only used where it is technically imperative and in the smallest amount technically feasible. Their replacement is regularly reviewed by manufacturers for economic reasons.
The restriction of fluoropolymers like PTFE, PVDF etc. is not justified, as these substances are essential in the manufacture of batteries, and we do not see a risk in their use for public health or the environment.

Volkswagen Group proposes the following exemption from PFAS restrictions regarding batteries:

- **Applications for the production of lithium-ion batteries for transport vehicles and energy storage systems, e.g., binder for the coatings of the electrodes. This exemption shall be reviewed and assessed by the Commission no later than 13.5 years after EiF.**
- **Batteries for transport vehicles for repurpose use e.g., as energy storage devices.**
- **Additives for electrolytes for lithium-ion batteries for transport vehicles and energy storage systems. This exemption shall be reviewed and assessed by the commission no later than 13.5 years after EiF.**

3.3. Electronics

Use case and significance
Automotive electronics represent one of the most important elements for today's and future mobility solutions, like electromobility, autonomous driving and connectivity but also for further current countless applications within the whole supply- and production chain, which all would be affected by the proposed PFAS restriction.

The dossier submitter has identified "Transport" and "Electronics and semiconductors" as independent main applications (sectors). But, in fact, there are many connections between these two sectors. This became visible during the semiconductor shortage which led to global production delay and stops by many OEMs in 2021 and 2022.

PFAS, especially fluoropolymers (e.g. PTFE, PVDF) and fluoroelastomers (e.g. FKM) are used in a variety of electronic products and parts such as:

- Wires, cables, harness
- Electronic control units (ECU)
- Semiconductors
- Capacitors
- Inducers and Magnetics
- Switches and Fuses
- Sensors
- Coatings, pottings, gels
- Printed Circuit Boards (PCB)

In general, the requirements for electronic components in the automotive industry are much higher than those in the consumer sector. The components must reliably operate e.g., in high-temperature environments and withstand shocks and vibrations over an extended period and are therefore subject to time consuming developmental and approval processes.

For most of the uses, there are no alternative materials foreseeable that possess the same characteristics in terms of mechanical, thermal, and durable properties as fluoropolymers.

It is important to point out, that today's performance and use of electronics will immediately become impossible after EiF of the proposed restriction.

Changes to critical elements or the product's design require intensive testing, reevaluation, and, if needed, the renewal of product certifications.

As per the restriction dossier and information from the German Federal Environment Agency (UBA), the electronics/semiconductors and energy sector presently account for a share of less than 2% in the overall PFAS emissions within the European Union.

During manufacturing of electronic components suppliers and producers handle PFAS with care and in accordance with applicable regulations regarding hazardous chemicals, occupational health and safety as well as emissions to the environment.

Closed systems, extraction and separation plants are commonplace. No reasonably foreseeable emission of PFAS occurs into the environment during use.

It should be noted, that the PFAS substances are enclosed as part of the relevant material. No release of PFAS-substances takes place over lifetime. After reaching their end of life, vehicles and also PFAS containing articles in electrical and electronic equipment are collected and handed over to a proper recycling in accordance with applicable regulations e.g., Waste Framework Directive (WFD) 2008/98/EC, ELV Directive 2000/53/EC and WEEE Directive 2012/19/EU.

Additionally, latest studies confirm that fluoropolymers at their end of life when incinerated under representative European municipal incinerators conditions do not generate any measurable levels of PFAS emissions and therefore potentially pose no risk to human health and the environment. [source: Waste incineration of polytetrafluoroethylene (PTFE) to evaluate potential formation of per- and poly-fluorinated alkyl substances (PFAS) in flue gas, 2019, Wexler et al.]

Conclusion and proposed amendment
The planned exemptions made within the restriction proposal are inadequate and do not consider the significance of PFAS in multiple applications and potential innovations in the electronics and digital industry.

General and extended derogations are essential, particularly when no technically appropriate and environmentally safer alternatives are available.

The dossier submitter did not propose a derogation for PFAS in electronics. Therefore, we propose to add a derogation for electrical and electronic components for 13.5 years. This exemption shall apply perpetually, but may be reviewed and reassessed by the EU-Commission no later than 13.5 years after EiF.

3.4. Seals and Hoses

Use case and significance

The complexity of applications and functions to be realized by seals and hoses in vehicles is very high.

Fluoroelastomers such as FKM, FFKM and FVMQ as well as some other classes of fluorinated plastics such as PTFE or PVDF are used in demanding seal and hose applications. The materials are either used as bulk materials, or as single layers in multi-layer constructions, or as coatings. While some applications will disappear with the end of ICE technology others are not related to ICEs and will remain important components also in BEV vehicles. Also new products are currently being developed in the field of electric drives.

Examples for important seals and hoses used in current ICE technology made from or using fluoroelastomers, PTFE or other fluorinated plastics are valve stem seals, crank shaft seals, fuel injector seals and generally the majority of seals used on the fuel circuit, intake manifold seals, oil seals and O-rings for engine and transmission, fuel pump seals, high temperature coolant seals, oil separation membranes, timing and drive belts, fuel hoses, turbo charger hoses, hose lines for DEF lines and DPF/GPF control lines. Components that are phasing out with the combustion engine cannot simply be converted. Due to the de facto phase out of combustion-engine vehicles in 2035 intensive development activity or investments are not economically justifiable and disproportionate in view of the remaining short runtime and the required phase-in time of PFAS-free ICE-cars.

Examples for important seals and hoses related to BEV vehicles are seals for thermo management such as newly developed dielectric cooling fluids for active battery cooling, seals for compressors e.g., in air conditioning, air springs or fuel cells, oil seals and O-rings in e-engine and e-transmission, brake vacuum hoses and thrust washers.

Fluoropolymers are used in all the cases mentioned because of the following unique properties or combinations thereof: high temperature and media stability (fuels, acids, bases, high performance lubricants such as motor and gear box oils, hydraulic fluids), excellent wear resistance and low friction properties, corrosion resistance and permeation tightness. It is important to note that fluoropolymers are among the highest priced polymers and there is a significant gap to other classes of polymers. They are therefore only used today in applications for which there are no technical alternatives.

Replacing fluoroelastomers, PTFE or PVDF in sealing and hose applications with other polymer classes always comes with a loss of performance and/or a significantly reduced lifetime of the respective component. This loss of functionality easily leads to premature component failure, causing leakage and associated safety issues, as well as emissions of the respective fluids to the environment. Complex and expensive core systems such as the engine, transmission or the fuel

system pose a high risk of serious damage if a seal or hose fails, which can result in the entire vehicle breaking down.

Other polymer classes are more permeable to liquids and gases than fluoropolymers and therefore lead to emissions of functional fluids such as fuels, coolants or lubricants. Seals used in dynamic applications which renounce the use of fluoroelastomers and PTFE are subject to premature wear due to higher abrasion and cause increased fuel/energy consumption due to increased friction.

Therefore, seals and hoses would need to be replaced regularly as a preventive measure, necessitating frequent and expensive service intervals. In many cases, replacing a seal or hose is entirely not feasible.

To ensure proper functioning, fundamental engineering changes on motor vehicles currently in production are based on type approval processes implemented by national transport authorities of EU member states. If possible, a single material change in such a scenario affords up to eight years in average from initial request to fully validated approval.

Conclusion and proposed amendment
Seals and hoses containing PFAS polymers of low concern shall be exempted from the restriction proposal. This exemption shall apply perpetually, but may be reviewed and reassessed by the commission.

Seals and hoses where the use takes place under highly demanding conditions, or where the use is needed for proper and safe functioning or safety of equipment shall be exempted from the restriction proposal. This exemption shall apply perpetually, but may be reviewed and reassessed by the commission.

3.5. Lubricants

Use case and significance
The complexity of applications and functions to be realized by lubricants in vehicles is very high. PFAS-containing lubricants (coatings, greases, paints, etc.) at various sealing and functional points in BEV, Hybrids and ICE are irreplaceable to realize critical functions such as wear protection, reduction of friction & noise, material compatibility and insolubility (e.g. with fuel). Their special properties mean that they are indispensable, especially for harsh conditions and are in this matter currently without substitutes.

Their range of applications is very divers and includes - among others:

- Electric drive
- Transmission
- Air conditioner

- Refrigerant compressor
- Cooling system
- Brake
- Damper
- Steering
- Headlights
- Doors

Replacement with PFAS-free lubricants would mean a significant reduction in service life (up to 90%), an increase in customer complaints and disadvantages in global competition. Furthermore it will boost CO_2 emissions due to increased friction and wear.

Alternatives for harsh conditions (temperature, pressure, chemicals) are not available or foreseeable. For less harsh conditions PFAS free alternatives are partially available. However, it must be taken into account that even for available substitutes, a complex development and release process is required for a changeover.

Conclusion and proposed amendment
PFAS-containing lubricants shall not be prohibited for use cases under harsh conditions or where the implementation of safety-related functions is required.
This exemption shall apply perpetually, but may be reviewed and reassessed by the commission.

3.6. Hard chrome Plating

Use case and significance
The use of PFAS substances in chrome plating is limited to a process aid in hard chroming processes as a mist suppressants, where the PFAS substances are used therein in a closed loop systems to reduce the emissions of mist and therefore explicitly increase workers safety.

Within this application, the PFAS substances do not enter the final product and remain in the processing media.

Examples for functional uses are

- coatings applied in ICE engines, like fuel injectors, valves and piston rings
- chrome plating in damper piston rods as standardizes application in all vehicles
- brakes

Nowadays the use of chromium within the hard chrome plating process is already intensively restricted by REACH regulation, allowing the use of chromium only in authorized cases, where no alternative is available.

Furthermore mist reduction of hard chrome plating has been seen of high importance to allow derogation under the EU-POP regulation even for the harmful PFOS if no alternative exists.

Despite the existing derogation, the industry has accepted the harmful properties of PFOS on the environment and developed alternatives based on incompletely fluorinated octane sulfonic acids as spray suppressant such as 6:2 fluorotelomer sulfonic acid (6:2 FTS).

PFAS-free substitutes for mist suppressants are possible to apply in decorative chrome plating but not in hard chrome plating. A general reason is found in the much higher current density and the much thicker layer structure in the hard chrome plating that causes the interference with these other mist suppressants or their degradation products.

Conclusion and proposed amendment
Without any doubt, a restriction of PFAS substances for the underlying processes in the European economic area would lead to an extreme burden on chrome plating companies and, in the foreseeable future to an extinction or a relocation of companies from the European area and specific knowledge as well.

The current proposed restriction considers a potential derogation for the use of PFAS in hard chrome applications for consideration and 6.5 years estimated.

The purpose of the derogation under the EU POP regulation is emission reduction and workers safety by mist suppressant with the hazardous substance PFOS. Nowadays, harmless alternatives such as 6: 2 FTE has been developed, are available and already in use. Therefore, these recently introduced, alternative mist suppressants should be derogated for 13,5 years from the planned PFAS restriction to be in line with the authorized hard chrome uses under EU REACH and the EU POP regulation.

Further regulatory decision making should be in line with the general regulatory conditions towards the use of chromium within chrome plating processes.

3.7. Production

Use case and significance
In almost all industrial productions, PFAS can be found in the resulting products as well as in the manufacturing processes and the associated machines and systems. The positive properties of PFAS have led to many innovative further developments in machinery and processing aids, and due to their outstanding properties, they are used in a variety of ways.

Machinery are long-term capital goods
Production facilities in the automotive industry are a very durable investment good that is handled very professionally over the entire life cycle of several decades.

A regulation that makes no distinction between new plants and existing plants endangers the continued operation of existing machines and plants. In some cases, this includes systems that have been in use for decades – and whose planned service life is far from being reached.

Regulation must therefore make a distinction between new systems and old systems; whereby old systems also include regular maintenance and repairs with the corresponding spare parts. Likewise, the affected processing aids of such plants can only be replaced if there are substitutes.

Individual components in these complex systems often cannot be replaced without a significant intervention in functionality, especially when elementary properties are changed. This would be expected in the event of a ban on PFAS in industrial components without replacement.

It is necessary to ensure that spare parts for these plants are available throughout the entire operating cycle in consistent quality with consistent properties in order to safeguard the investments made and not jeopardize competitiveness. A premature replacement of machines and systems jeopardizes investments made and must not be sought from the point of view of sustainability. Likewise, the usual further use must be possible until the end of the technical service life of used machines.

For this purpose, the time horizon of capital goods must be taken into account. Even a derogation period of 13.5 years is often far too short here. Accordingly, a much longer exception must apply to components and process equipment for existing plants and their maintenance and spare parts.

Use of PFAS in machinery
PFAS are used as part of machine components in numerous applications. These include, for example, seals, valves, diaphragms, insulators, cables, semiconductors and coatings. Spare parts containing PFAS are necessary for the long-term operation of the machines and systems, as long as no equivalent alternatives are available. Currently, the use of PFAS in existing machines and systems is not fully known due to a previously non-existent PFAS declaration obligation. Such a declaration obligation for new systems is necessary.

Use of PFAS as a processing aid in production
PFAS in processing aids can only be evaluated if they are communicated to the downstream user. For hazardous mixtures containing classified PFAS, the information is provided in the safety data sheet. Unclassified PFAS or mixtures containing PFAS in low concentrations shall be communicated by means of data sheets in accordance with Article 32 and the content limits of the restriction. A precise declaration obligation is also necessary to be able to subsequently develop the possible substitutes or process changes.

Process aids include: lubricants and release agents, heat transfer fluids, test gases, electroplating additives, adhesives, cleaning agents, solvents and auxiliary materials in the painting process.

For numerous applications, e.g coating processes, there are currently no discernible alternatives, which would lead to significant production restrictions if banned.

Conclusion and proposed amendment

1. General exemption for spare parts for machineries based on the "repair as produced" principle
2. Derogation for the process aids, such as refrigerants for refilling of HVACR equipment, which are necessary the maintenance and repair of existing machineries
3. Obligation to declare PFAS in machinery and processing aids
4. Exemptions for the sale and trade of existing machinery

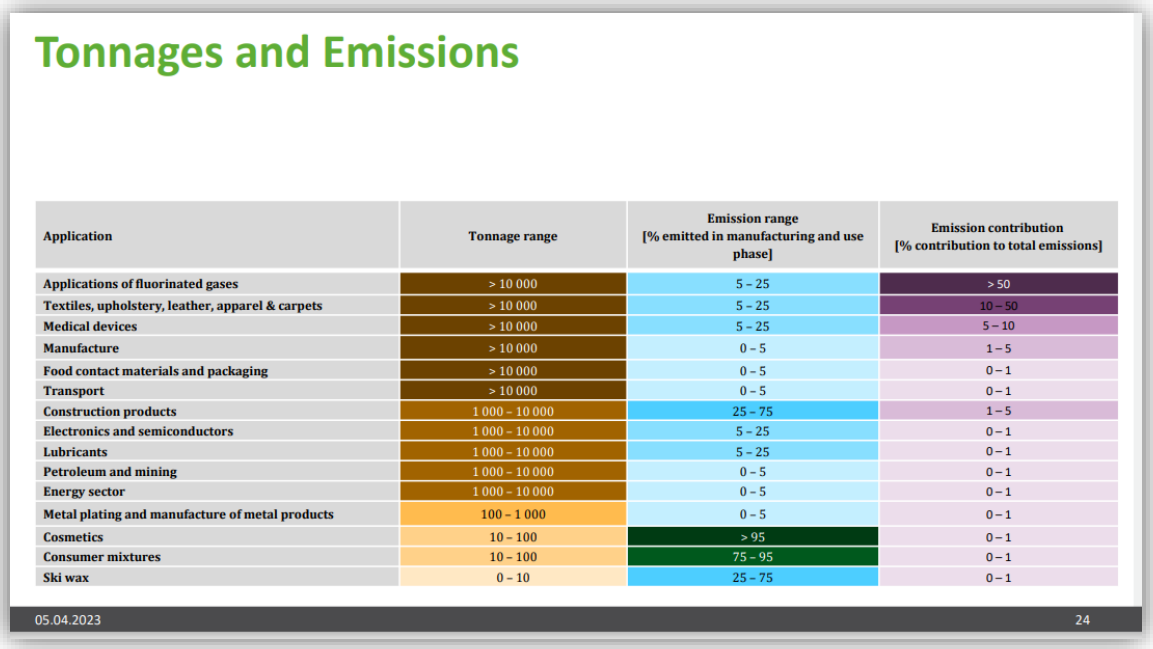
4. Focus: Mobile Air Conditioning (MAC) refrigerant

In terms of quantity, the PFAS (2,3,3,3-tetrafluoropropene - trade name R1234yf) found in the synthetic refrigerant of the mobile air conditioning system accounts for the majority of PFAS in the vehicle after the high-voltage battery.

However, unlike high-voltage battery, the refrigeration circuit is not a completely dense system, and small quantities of refrigerant are released into the environment even during regular operation and over lifetime. The emitted F-gas R1234yf is particularly volatile and environmentally effective and decomposes into trifluoroacetate (TFA) within a few days. TFA is persistent. The risk to humans and the environment from these emissions has not been conclusively clarified.

90% of the total emissions out of MAC systems are generated in the use phase of the car and only 10% in the production/filling and disposal phases. Mobile air conditioners are the source of 75% of the non-degradable TFA volumes produced in Europe (approx. 30,000t in 2030). (Source: UBA 73/2021 "Persistent degradation products of halogenated refrigerants and blowing agents in the environment: type, environmental concentrations, and fate with particular regard to new halogenated substitutes with low global warming potential").

ECHA's illustrations also show the dominant influence of fluorinated gases, such as 2,3,3,3-tetrafluoropropene, on the total PFAS occurrence in the main fields of application in terms of quantity and emissions – figure 1.



Tonnages and Emissions

Application	Tonnage range	Emission range [% emitted in manufacturing and use phase]	Emission contribution [% contribution to total emissions]
Applications of fluorinated gases	> 10 000	5 – 25	> 50
Textiles, upholstery, leather, apparel & carpets	> 10 000	5 – 25	10 – 50
Medical devices	> 10 000	5 – 25	5 – 10
Manufacture	> 10 000	0 – 5	1 – 5
Food contact materials and packaging	> 10 000	0 – 5	0 – 1
Transport	> 10 000	0 – 5	0 – 1
Construction products	1 000 – 10 000	25 – 75	1 – 5
Electronics and semiconductors	1 000 – 10 000	5 – 25	0 – 1
Lubricants	1 000 – 10 000	5 – 25	0 – 1
Petroleum and mining	1 000 – 10 000	0 – 5	0 – 1
Energy sector	1 000 – 10 000	0 – 5	0 – 1
Metal plating and manufacture of metal products	100 – 1 000	0 – 5	0 – 1
Cosmetics	10 – 100	> 95	0 – 1
Consumer mixtures	10 – 100	75 – 95	0 – 1
Ski wax	0 – 10	25 – 75	0 – 1

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Figure 1 PFAS Tonnages and Emissions
[Source: ECHA, Webinar: Consultation on restriction proposal for per- and polyfluoroalkyl substances (PFAS) of 05.04.2023]

This proves why, with regard to the necessary reduction of PFAS emissions, the focus on the conversion of the refrigerant is correctly chosen.

By converting the refrigerant circuit from F-gas R1234yf to the natural refrigerant R744 (CO_2), PFAS in the refrigerant can be eliminated and thus the PFAS emissions of the vehicles can be significantly reduced.

Consequently, Volkswagen Group is focusing on a rapid conversion of the refrigerant towards R744.

4.1. Technical implementation of an alternative for R1234yf refrigerant

The following explanations apply exclusively to passenger cars.

The natural refrigerant R744 (CO_2) is an alternative to the F-gas R1234yf, which is currently mainly used.

R744 has significantly different thermodynamic properties. Therefore, the conversion from F-gas R1234yf to the natural refrigerant R744 (CO_2) requires a **completely new layout of the refrigeration circuit**. The reasons for this are higher pressure levels (130bar instead of 32bar) and smaller molecular sizes of the R744, for which all components have to be adapted. In addition the new refrigerant requires a new package, as new and additional components such as refrigerant receiver, internal heat exchanger (IWT) and a CO_2 sensor have to be added to the MAC system. As a result, all system components, including the system software, have to be redesigned and developed. Validation testing must be carried out for all regions in terms of fatigue strength and performance. Homologation and implementation processes also have to be done.

For economic and capacity reasons in development, the development of an entirely new R744 circuit can only be done in the case of a new vehicle development.

Refrigerant circuits with R744 refrigerant are currently only available for serial application for some of the Volkswagen Group's BEV models. A complete changeover to R744 for all models therefore requires a new development of the refrigeration circuit for vehicles that have not yet been converted to R744, with an impact on the design of the front end, including the necessary validation. The production facilities at OEMs and suppliers must also be converted to R744.

Generally, vehicle development and production adaptation take place at different times in model cycles of 5-7 years. It is impossible to change the entire range of products in ongoing production at one time (development and supplier capacity, production changeover, homologation for all variants). Equalization and displacement are necessary due to the large number of vehicles.

In the case of a changeover at only one key date, the development time for all vehicle models in the Volkswagen Group would be compressed to 18 months - the available capacities, which cannot be increased within the needed time, are not sufficient for this.

In the event of a changeover outside the model cycles, additional development and investment costs amounting to billions of euros are incurred that would be missing for electrification. The main reason for this is an additional complete vehicle test to be carried out, including crash tests.

It is therefore necessary to apply a transition period to deliver the required time.to run all development and homologation processes in a timely and subsequent manner, adjusted to capacities and taking into consideration the wide range of the car portfolio being affected in the automotive industry and at each manufacturer.

4.2. Timeline for refrigerant changeover

The present restriction proposal provides for a transitional period of 18 months for the switch to PFAS-free refrigerants for vehicles with electric compressors.

When deciding on the transition period, not the drive of the compressor (electrical vs. mechanical) should be the decisive element, but rather the drivetrain of the vehicle itself, as this dictates the technical boundaries and challenges (temperatures, vibration profiles) the MAC has to function within. Therefore, we propose to distinguish for all boundaries and exemptions between ICE vehicles and BEV vehicles. Hybrids should be considered as ICE vehicles - independent of how the MAC system is driven.

The restrictions described above, which are entailed by the various drive types BEV and ICE, lead to different implementation scenarios. This is illustrated in the following chapters.

4.3. BEV (Battery Electric Vehicle)

VW Group is working to convert all BEV models to the refrigerant R744. To securely reach this change the Group is already working on appropriate systems in development. As development, testing and homologation requires several years in car industry, the market introduction of first new BEV platforms using R744-only will start during the second half of this decade. Due to our broad product portfolio and the limited capacities inhouse, at suppliers and at homologation services and authorities this overall transformation towards R744 takes several years until **end of 2030 to change all major BEV-platforms.**

Only for limited sales volume based on old BEV-platforms we recommend to offer an additional time before end of production. Changing these platforms would cause major additional burden inhouse and at homologation and approval authorities with very limited environmental benefit.

4.4. ICE (Internal Combustion Engine, incl. Hybrids)

The new development of the refrigeration circuit would be much more complex for vehicles with ICE than for BEVs, since the boundary conditions (including temperature and vibrations) in the front end are much more challenging than with BEVs. In addition the portfolio of ICE cars is broad, covering different platforms and engine designs and requiring individual developments, applications and homologations. All has to be done at the same time, BEV-models have to be shifted towards R744. Therefore, the Group's ICE models could only be **finally converted to R744 usage not earlier as of 01.07.2034**.

In the same timeframe ICE volumes in total will be reduced and ICE finally phasing-out latest in 2035 through regulatory boundaries (CO_2-regulation). MAC-system changes for ICE through the PFAS ban will therefore be unproportional regarding effort of capacity and financial resources compared to environmental benefit. Based on this we propose to exempt all MAC-systems of ICE-based vehicles from the discussed PFAS-restrictions.

Technical Explanation
For all vehicles with combustion engines (ICE incl. hybrids), a new component and series development in the vehicle and, in parallel, a ramp up of suitable suppliers for R744 MAC is necessary. Sealing systems for R744 are critical due to the high pressures (130bar instead of 30bar) and the small molecular size. At the higher temperature in the ICE (125°C instead of 85°C), the leakage of the system increases and thus the necessary service interval is shortened. Furthermore, the vibrations of the combustion engine worsen the tightness. The know-how of the R744-MAC systems in series production on BEV vehicles cannot be fully adopted, as the temperatures and vibrations in the front end are significantly higher than in a BEV. This has an influence in particular on the components compressors, refrigerant valves and connection points. Due to the higher water temperatures of the drive (combustion engine), other conditions prevail, especially in the radiator package, in which the gas cooler of the air conditioning system is positioned, which influence the cooling capacity and efficiency of the system.

It must also be noted that the automotive industry is in a difficult phase of transformation towards alternative drive technologies. Due to the CO_2-fleet regulation, cars and vans with combustion engines including plug-in hybrids will be phased out anyway. Large investments in vehicles with combustion engines forced by a PFAS-phase out as proposed are not economically justifiable and disproportionate in view of the remaining short runtime and the required phase-in time of PFAS-free ICE-cars. Also it must be noted that high investments are already needed to

implement the EU 7 emissions standard to further reduce emissions significantly. All major investments into ICE technology are at the expense of electrification and the development of the associated charging infrastructures. For this reason, it must be ensured that additional regulations for vehicles with combustion engines are reduced to an absolute minimum and required exceptions for the combustion engine and drivetrain are considered.

4.5. Export and testing/development

Vehicles for export are to be permanently excluded from the restriction.
The export of vehicles from the EU with original refrigerant must remain possible in the long term in order to prevent socio-economic disadvantage for the European automotive industry (e.g. export to Asia).

Technical development and testing of pre-production cars should be exempted from any refrigerant restrictions as the development centers of the technical developments of the Group's brand are within Europe. A total ban of F-Gas based refrigerant even for these special purpose non-series cases would endanger our connected development activities and the connected facilities here in Europe.

4.6. Conclusion

Volkswagen Group is striving not to invest disproportional resources into the development of ICE models. Instead, the full focus is being placed on climate-decisive electrification. According to our objective towards environmental friendly transportation we want to focus on our growing fleet of BEV which will be converted as quickly as possible according to technical feasibility towards PFAS-free refrigerant R744.

The overall overview is shown in Figure 2.

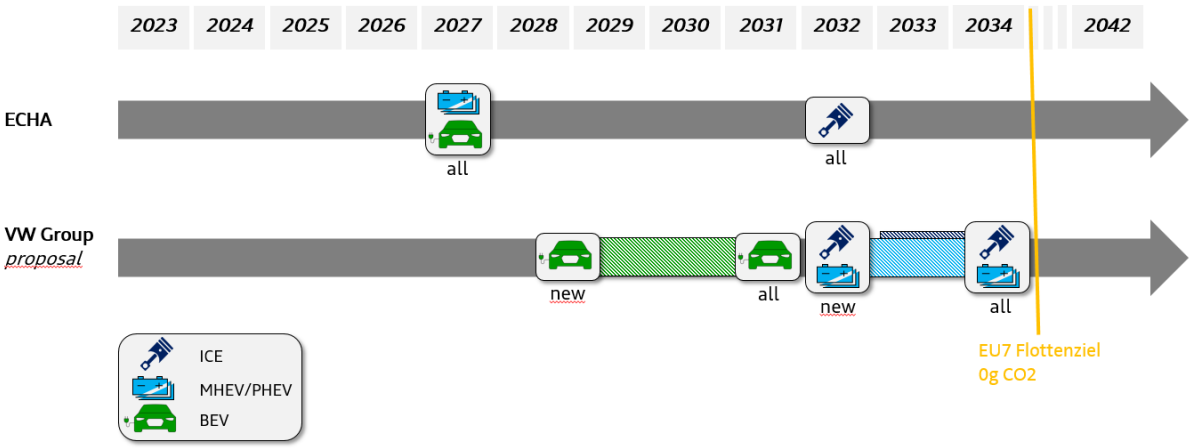

Figure 2_ Timetable for changeover