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22 September 2023

PFAS REACH Annex XV Restriction Report

1ST Public Consultation (22 March – 25 September 2023)

Request for an exclusion or a time-unlimited derogation of certain fluorinated materials used in Aerospace and Defence applications from the PFAS REACH restriction Proposal.

Table of Contents

1 Executive summary

Honeywell International Inc. and its affiliated companies (hereinafter **- Honeywell**)[1] are global providers of various equipment and materials for aviation, space, and defence sectors (**Aerospace & Defence** or **A&D**), including use in critical components of aircrafts/vessels/satellites/rockets/missile actuation systems, thermal management, life support, avionics, fuel supply, engines, auxiliary power units, navigation, communication, microelectronics, sensors, radars, insulation, hydraulic and many other respective equipment/applications.

Numerous key components of this equipment such as adhesives, seals, batteries, bearings, gaskets, hoses, O-rings, insulation, tubing, cables and wiring, filters, barrier films, refrigerants, fire suppression gases, etc. are made of PFAS (incl. fluoropolymers, (per-)fluoroelastomers, fluorocarbons) and are commonly referred to below as **Fluorinated Materials**. [2]

[1] See the list of acronyms and abbreviations (aligned with the Proposal) in **Annex I** below.

[2] The list of PFAS substances containing in components and materials used in Aerospace & Defence applications is provided in **Annex II** below.

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On 13 January 2023, the competent authorities of five EU/EEA states (**Dossier Submitters**) submitted the *PFAS REACH Annex XV Restriction Report* (**Proposal)** to the European Chemical Agency (**ECHA**).[3] The Proposal covers all PFAS and their uses, including in all gas detector applications.

Considering the importance of Fluorinated Materials for safety and demanding performance within the overall A&D sector as well as the absence of feasible alternatives and very long substitution periods typical for the industries in question, it is justified to either exclude these substances used in A&D applications from the Proposal or make all PFAS uses within the A&D sector subject to a time-unlimited derogation.

In this regard, most materials in question are **fluoropolymers** with physicochemical characteristics and exposure profiles that are different from most other types of PFAS substances, satisfy the OECD criteria for a Polymer of Low Concern (PLC)[4], and are deemed to be environmentally and humanly benign. They do not exhibit any of the intrinsic hazards assessed in section 1.1.4 of the Proposal and are not substances with similar PBT/vPvB concerns. Their grouping with "*all other PFAS*" for the purposes of risk assessment is not scientifically and legally justified.[5]

Honeywell does not manufacture the components/products and fluorinated materials in question in the EU/EEA. They are imported into EU/EEA for use in various articles (such as batteries, brake coating, tubes, tapes, wiring, etc.) or in closed/sealed systems (e.g., heat transfer fluids in various mechanisms and electronics) specifically designed to exclude PFAS emissions during their use.

Health and environmental risks associated with the end-of-life stage of A&D equipment (decommissioning, dismantling and recycling/reuse) are subject to strict national and international requirements as well as voluntary programmes, e.g., for aircrafts.[6]

In addition, electrical and electronic equipment (and components) of civil aircrafts are subject to disposal requirements under EU *WEEE Directive*, *Waste Framework Directive* (WFD) and various national laws and practices.[7] Incineration of these fluorinated materials under standard European municipal waste incineration conditions, particularly at temperatures above 850°C, has been assessed under EU and national waste legislation.

Due to their unique physicochemical properties, these fluorinated substances exhibit exceptional characteristics for materials and equipment required by the A&D industry and mandated under applicable SAE Aerospace Standards (AMS) as well as European Union Aviation Safety Agency (EASA) regulations/certificates and competent aviation authorities worldwide (e.g. the U.S. Department of Defense, Federal Aviation Administration, etc.). All technical specifications (see, e.g. AMS3255 or AMS3678 standards) need to be complied with simultaneously in all jurisdictions where aircrafts are produced, used flown, and serviced.

3 On 22 March 2023, ECHA published the *PFAS REACH Annex XV Restriction Report* in the Registry of restriction intentions until outcome and started the 1st *Annex XV report consultation* with a final deadline for comments on 25 September 2023.

4 See detailed analysis in *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers*, Stephen H. Korzeniowski *at al.*, Integrated Environmental Assessment and Management — Volume 19, Number 2—pp. 326–354, 2022.

5 *Ibid.*, page 348-349.

6 See e.g., on The Aircraft Fleet Recycling Association (AFRA) and *International Civil Aviation Organization (ICAO) 2019 Environmental Report*.

7 *Regulatory Management Option Analysis (RMOA) for Fluoropolymers*, Fluoropolymers Product Group, PlasticsEurope., page 350.

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Due to the specifics of A&D uses, known alternative materials are not able to simultaneously satisfy all required properties, such as low flammability, high service temperature (above ~200 °C), low dielectric constant, electric arc tracking resistance, mechanical strength and elasticity, and chemical resistance/inertness to even the most aggressive chemicals. In this respect, in many essential A&D applications only Fluorinated Materials can fulfil all required technical specifications.[8]

Moreover, the combinations of properties required in most A&D applications will be difficult to achieve in a new material. Even after a material with the suitable combination of properties would be discovered or invented, it will take decades to approve its uses by the overall A&D industry (e.g., all major aircraft producers should test and approve) and to certify it under all applicable standards worldwide. The overall substitution timeframe would exceed the longest (13.5-year) derogation period advocated in the Proposal (particularly in cases where there are no “simple” drop-in solutions). It is estimated that, in practice, this process would require approximately 30 years (on average) for many critical aircraft components. In this situation a complete exclusion from the scope of the PFAS restriction or a time-unlimited derogation is highly warranted.

Alternatively, the proposed universal PFAS REACH restriction would have a heavy socio-economic impact on the industry and for all of society that cannot be overestimated. Although it is objectively impossible to quantify tonnages/emissions resulting from PFAS uses in the A&D sector and the costs of their substitution, the proposed ban will tremendously affect economic, environmental and social aspects of the A&D sectors as well as jeopardise the safety of passengers and national security.

Therefore, the ban on the use of fluorinated materials in A&D applications/equipment is disproportionate to the alleged risks to health and the environment due to their persistency characteristics. The proposed REACH restrictions will inevitably result in very high costs on the society. These consequences also contradict the wider EU industrialisation and competition policies as well as the objectives of the European Green Deal, REPowerEU and other emerging sustainability laws.

Honeywell submits that uses of Fluorinated Materials in A&D applications should be excluded or made subject to a time-unlimited derogation from the proposed PFAS REACH restriction.

2 Important features of materials used in A&D applications/components/devices.

Only Fluorinated Materials, such as PTFE, FKM and FEP, provide the required complex combination of physical and chemical characteristics needed for materials used in the A&D sector, including: improved strength and fire resistance of structural materials (clamps, insulators, pipes, etc.), low dielectric constant and high arc tracking resistance - crucial for the safety and integrity of high speed–low signal loss systems (in-flight control, satellite navigation, communication, etc.), shielding against electronic interference (e.g. from other devices, electric storms), chemical resistance to various oils, hydraulic and electrolyte liquids (e.g., batteries, capacitors, etc.) and aggressive fuels, as well as protection of crew, passengers and cargoes from extreme cold, moisture, and altitude changes. These lifesaving applications depend on the reliable performance of all respective systems for long periods of use, requiring minimal maintenance down times.

[8] For example, technical specifications for PTFE / ETFE insulated wire under M22759 (SAE AS22759) standards or requirements for heat transfer fluids, solvent resistance O-rings, etc.

- **Highest mechanical resistance, durability, and smooth surface**

Importantly, all materials and equipment/components of e.g., aircraft/missile must be sufficiently strong, light, and durable. Equally, each part should be sealed and attach/detach-able to perform maintenance and if required by normal operation. For example, moving parts coated with e.g., PTFE can glide over each other with much less friction. This leads to reduced abrasion and less wear and tear.

For instance, only Fluorinated Materials such as PTFE, FEP, PFA and certain others provide the self-lubricative, chemically inert/resistance properties during extreme temperature service conditions encountered by a wide range of aircraft applications.

- **Wide temperature servicing ranges (from -80 to over +270 °C)**

Only a few plastics and similar suitable materials (e.g., fibres, ceramics) are capable of providing stable and reliable functionality as materials and equipment/components in a wide range of temperatures such as from -80 °C needed in some space programmes to over 270 °C common for various A&D applications (e.g., engines, heat exchangers, certain actuators, etc.).

For example, standards AMS7276, AMS7287, AMS3651, AMS3667, AMS7255, AMS-P-5315, AMS3375, AMS3325, AMS7257, MIL-P-46183, etc., require stable operations of materials in temperature ranges from -40 to +288 °C.

Only a handful of fluorinated materials can ensure service integrity and reliability at such temperatures and in multiple types of environments, where rapid changes in temperatures are combined with high radiation and pressure variations (e.g., missiles, or space travel).

Another important feature of Fluorinated Materials is that the temperature range in which they are used is vastly wider than existing service temperatures of any other materials. This allows for additional expansion for new product development while still using an existing material base.

- **Chemical inertness and resistance**

Many components of A&D equipment (hoses, tapes, lip seals, etc.) are in direct contact with various aggressive and corrosive chemicals used in hydraulics/pneumatics, Heating Ventilation and Air-Condition (HVAC), fuels and fire protection systems of airplanes and/or satellites/spaceships.

For instance, resistance of respective materials to chemicals, humidity, impact, temperature, their corrosion resistance, adhesion, hardness, compatibility with other layers are all extremely important features for all types of coatings (primers, topcoats, insulation, etc.) in the A&D sector. They have a strong influence on the safety and reliability of all products and are closely controlled (by the government, through military standards, original equipment manufacturers (OEM) specifications, etc.).

Only the fluorinated materials in question (e.g., PTFE, FKM, FEP, etc.), which have the highest chemical inertness and resistance to the aggressive and corrosive substances, can provide the required chemical-resistance. This greatly improves the reliability and long servicing life (incl. less maintenance) of the components in question and overall flight safety.

- **Low dielectric constant and high arc tracking resistance**

Fluorinated materials, such as PTFE, FKM, and others, are also characterised by low dielectric constant and high arc tracking resistance characteristics.

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These are crucial properties for all cables, wires and optical fibres used in aerospace and defence equipment, which often operate at very high voltage and/or experience high power surges (lighting, batteries/capacitors failures, etc.).

Also, high frequency circuit materials utilize ceramic-filled PTFE composites that play a key role when used in defence and commercial microwave and RF applications.

Fluorocarbons such as HFE, or perfluoro compounds, C5-18 based fluids are mainly used for cooling, firefighting, and lubricating applications due to their low flammability, and excellent dielectric properties along wide ranges of working temperatures.

However, it is specific combinations of above properties across broad ranges of environmental conditions in specific Fluorinated Materials which make them unique for uses in most critical A&D applications where trade-offs and compromises are too risky. This approach is reflected in relevant technical regulations/specifications that are heavily enforced within the sector, as demonstrated below).

3 Mandatory technical specifications

The A&D sector is extensively regulated worldwide by comprehensive technical regulations and standards. Each component/equipment/material of e.g. an aircraft or missile must comply with complex SAE Aerospace Standards (Aerospace Material Specifications (AMS)) and European Union Aviation Safety Agency (EASA) regulations. AMS specifications cover materials, material tolerances, and quality control procedures and processes. All those technical specifications (see, e.g. AMS3255 or AMS3678 standard) need to be met simultaneously across all jurisdictions where the aircraft is produced, used, flown and serviced. In addition, production should also adhere to strict quality management standards (incl. ISO AS9100 and Nadcap).

As demonstrated in section 2 above, due to the specifics of A&D uses, known alternative materials are not able to simultaneously satisfy all required properties, such as high service temperature (above ~200 °C), low dielectric constant, mechanical strength and elasticity, chemical resistance/inertness when exposed to the aggressive chemicals. In this respect, fluorinated materials are indispensable to ensure compliance with applicable technical specifications, as far as the most critical airworthiness and lifesaving components are at stake.

For instance, various AMS (e.g., AMS7276, AMS7287, AMS3651, AMS3667, MIL-P-46183) require resistance to high temperatures (from 135°C to 260°C) for various materials and components of an aircraft. There are only a few polymers capable of service in temperatures above 200°C. In the meantime, an electric arc tracking resistance (IMG 0 under IEC 60112:2020) is a crucial characteristic of insulation materials used in all carbon deposit electric systems/wires of airplanes, missiles, satellites etc. These are essential properties of A&D materials and defects result in airplanes disaster (e.g., upon UV radiation, batteries failure, cold temperature shrinkage, etc.)[9]. However, only PFA, PTFE, FEP fluoropolymers can satisfy both above requirements needed to fulfil the specifications for aerospace applications. Other materials capable to serve in such temperatures, Polyimide (PI), Polyamide-Imide (PAI), Polyether ether ketone (PEEK), Liquid Crystal Polymer (LCP), Polyphenylene Sulfide (PPS), or Polyphenylene Sulfone (PPSU)) are not arc tracking resistant.

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[9] See e.g., Arc Tracking Control in Insulation Systems for Aeronautic Applications: Challenges, Opportunities, and Research Needs, J-R Riba *et. all*.

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Also MIL-PRF-276717 military standard covers PFPE/PTFE based greases which are widely used as lubricants for bearings and other high-performance applications where hydrocarbon-based greases will not hold. There are numerous situations where non-PFAS materials are not capable of fulfilling mandatory high-performance technical specifications.

In this regard, SAE Aerospace specifications AMS3678 and AMS7287[10], were developed with the explicit purpose of setting forth criteria for fluoroelastomers and fluoropolymers (FKM, VDF-HFP, etc) seals, O-rings, compression seals, O-ring cord, moulded-in-place gaskets, and bearings in aircraft engine oil and aircraft jet fuel systems. These materials possess unique qualities, including a blend of friction and wear characteristics, as well as the capacity to withstand elevated temperatures when exposed to aircraft engine oils and aircraft jet fuels, features that are not simultaneously found in alternative polymer materials.

In other words, wide range of working temperatures, non-flammability and fire resistance, unique dielectric properties and high resistance to all fluids used in the A&D industry are key properties - found simultaneously only in Fluorinated Materials - needed for compliance with the most complex mandatory technical specifications specific to the industry.

4 Absence of unacceptable and/or not adequately controlled risk

4.1 Unjustified "grouping" of fluoroplastics and missing risk assessments in the Proposal

PTFE, FEP, ETFE, PFPE, PFA, FKM, FFKM, PCTFE and PVDF are polymer-type fluorinated materials (**fluoroplastics**). Although they are not registered under REACH, they satisfy all criteria of the internationally recognised OECD definition for a Polymer of Low Concern (PLC)[11]. They are scientifically proven to be low-hazard, non-toxic, non-mobile, and extremely inert materials without chemical or biological reactivity, and with excellent stability under a range of environmental and normal-use conditions.[12]

All available scientific data unequivocally demonstrates that the above fluoroplastics do not exhibit any of the hazards assessed in Section 1.1.4 of the Proposal and that their physicochemical, toxicological, and ecotoxicological properties are very different from many other PFAS. It is apparent that fluoroplastics do not exhibit PBT/vPvB equivalent concerns, contrary to the erroneous conclusions in section 1.1.6 of the Proposal.

Fluoroplastics mentioned above exhibit exceptional stability, as they are solid and inert. They are resistant to deterioration caused by various factors such as acids, bases, oxidants, reductants, light-induced

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10 AMS7287 - Fluorocarbon Elastomer (FKM) High Temperature / HTS Oil Resistant / Fuel Resistant Low Compression Set / 70 to 80 Hardness, Low Temperature Tg -22 °F (-30 °C) For Seals in Oil / Fuel / Specific Hydraulic Systems.

11 *Data analysis of the identification of correlations between polymer characteristics and potential for health or ecotoxicological concern*, OECD Environment, Health and Safety Publications, ENV/JM/MONO(2009).

12 Please find detailed assessment of PLC criteria of fluoropolymers in *A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers*, Barbara J Henry et all, Integrated Environmental Assessment and Management — Volume 14, Number 3—pp. 316–334, 2018; and more recent and detailed in *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers*, Stephen H. Korzeniowski *at al.*, Integrated Environmental Assessment and Management — Volume 19, Number 2—pp. 326–354, 2022.

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processes, microorganisms, and metabolic processes. As a result, they possess high resistance to thermal, chemical, electrical, and biological changes (i.e., crucial characteristics for A&D applications). These materials do not typically degrade under normal environmental conditions or during regular use and processing. They are notably durable and persist over time. However, it is important to note that persistence alone does not indicate any current or future risks from these substances to human health or the environment.[13]

Therefore, grouping the fluoroplastic materials in question with "*all other PFAS*" for REACH restrictions and/or read-across purposes is not supported by available scientific data and ECHA RAAF requirements.[14]

Moreover, all available scientific data suggests that "*segmentation based on properties should be conducted before performing any grouping-based risk assessment, placing stable, non-hazardous fluoropolymer materials that meet the criteria to be considered PLC in a separate category*".[15]

However, the required assessments are absent in the Proposal. In this case, the blanket application of generalised conclusions on PBT/vPvB and non-threshold properties of certain PFAS, as proxies to unacceptable risk, to all fluoropolymer materials without adequate and comprehensive risk assessments of their respective hazards and exposure, is not justified.[16] The adequate scientific assessment of the fluorinated materials in question, which is required to demonstrate the level of "*unacceptable risk*" under Article 68 REACH, is missing in sections 1.1.4., 1.1.5 and 1.1.6 of the Proposal.

In other words, the fluoroplastics in question are persistent, but they are not bioaccumulative, mobile, and (repro-)toxic (not PBT/vPvB or PMT/vPvM) and they do not exhibit similar concerns from a regulatory perspective.[17] Therefore, they should be excluded from the scope of the Proposal due to the lack of demonstrated unacceptable risks within the meaning of Articles 68 and 69 RECH Regulation.

4.2 Effective risk management measures already in place

Materials and components used in the A&D sector are subject to various stringent technical regulations during their production and use (see section 3 above) as well as end-of-life (both landfill and incineration) stages.

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13 See e.g. *Chemours Netherlands v ECHA*, Case T-636/19, Judgment of the General Court, 23 February 2022, para. 88; also *BASF Grenzach GmbH v European Chemicals Agency*, Case T-125/17, Judgment of the General Court, 20 September 2019.

14 See detailed discussion at pages 348-349 and Conclusions in *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers*, Stephen H. Korzeniowski *at al.*, Integrated Environmental Assessment and Management — Volume 19, Number 2—pp. 326–354, 2022.

15 *Ibid.*, at page 349.

16 See e.g., on three elements of risk - hazard, exposure, and risk based on the hazard manifesting themselves in the exposure in the specific case, *Fidenato v Comune di Padova*, Case C-442/14, *Commission v Germany*, Case C-47/90. *Etimine SA v Secretary of State for Work and Pensions*, C-15/10.

17 *Persistent, mobile and toxic substances in the environment: a spotlight on current research and regulatory activities*, Heinz Rüdel et al., Environmental Sciences Europe volume 32, Article number: 5 (2020).

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It is important to highlight that Fluorinated Materials used in Honeywell's A&D applications are not manufactured within the EU and risks pertinent to this activity are absent within the EU.[18] They are only imported in closed/sealed devices/equipment/systems under strictly controlled conditions, and therefore emissions during the use stage are avoided. The existing risk management measures and options (RMM and RMO) at use and end-of-life stages of materials are addressed below**.**

During the use phase, these materials (e.g., fluoroplastics) remain stable and inert. Non-polymeric materials, e.g., refrigerants, fire suppression gases, heat transfer fluids, lubricants and other materials are confined in closed and rigorously sealed devices/components, minimising PFAS emissions at their use stage. End-of-life disassembly and disposal are also rigorously controlled via existing national and international mechanisms/regulations discussed below.

There is also considerable data demonstrating that fluorinated materials, e.g., PTFE, FKM and other fluoroplastics, do not degrade in the environment or release substances of toxicological or environmental concern during the landfill disposal (i.e., negligibly leachable).[19]

Incineration of these materials under standard European municipal waste incineration conditions, particularly at temperatures above 850°C, has been assessed to be safe under the various EU and national waste legislation as noted above. [20]

Electronics (as well as components thereof) contained in aircrafts, including communications and avionics systems, may be subject to EU *WEEE Directive*, *Waste Framework Directive* (WFD)[21] and national waste related legislation of EU member states. These regulations could be amended at any time to accommodate appropriate handling of PFAS contained in waste streams of the aviation sector (collection, disposal, recycle, reuse, etc.), if warranted. These will be more proportionate and effective risk management options (RMO) than the restriction (i.e., bans) envisaged in the Proposal as far as uses of fluorinated materials in A&D applications are concerned.

Although EU *WEEE Directive* typically does not apply to military, defence or space EEE equipment and civil aircrafts itself, the latter are subject to various national (and international)[22] regulations aiming to ensure safe management of planes upon decommissioning. In this regard, aircraft dismantling and recycling facilities (need respective certification and license) and techniques must adhere to all relevant environmental

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[18] Within EU manufacturing processes of these devices and fluorinated materials in question are regulated by the EU Industrial Emissions Directive (IED)[18] and the recent *Responsible Manufacturing Commitment* of the industry. Quality management is subject to ISO AS9100 and Nadcap standards.

[19] Pages 350 in *A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers*, Stephen H. Korzeniowski *at al.*, Integrated Environmental Assessment and Management — Volume 19, Number 2—pp. 326–354, 2022.

[20] See e.g. *Waste incineration of Polytetrafluoroethylene (PTFE) to evaluate potential formation of per- and Poly-Fluorinated Alkyl Substances (PFAS) in flue gas*, K. Aleksandrov, 2019; *Investigation of waste incineration of fluorotelomer-based polymers as a potential source of PFOA in the environment*, P.H. Taylor, 2009; Per- and polyfluorinated substances in waste incinerator flue gases, Bakker, J., et al. (2021), RIVM report 2021-0143; *Using mass defect plots as a discovery tool to identify novel fluoropolymer thermal decomposition products*, Myers, A. L., et al. (2014).

[21] *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.*

[22] See e.g., on practices of the Aircraft Fleet Recycling Association (AFRA).

and occupational health regulations. These regulations typically cover safe removal of hazardous materials, such as fuels, oils, refrigerants, firefighting agents, hydraulic fluids, and other chemicals, from the aircraft before recycling or disposal. Proper operation of such facilities minimises any possibility of PFAS contamination.

In addition, techniques of aircraft recycling and the relevant market have a strong potential for growth and are developing rapidly.[23] In this regard, the Aircraft Fleet Recycling Association (AFRA) establishes standards and best practices which it uses as basis for its accreditation program for aircraft disassembly and aircraft materials recycling. For instance, the EU Tarmac Aerosave company actively engages in decommissioning and recycling in A&D sector. ICAO is also actively involved in promoting this type of activities.[24]

Further standardisation and regulation in aircrafts, space and defence systems at the end-of-life would be more efficient and proportionate risks management option (RMO) for fluorinated materials in A&D applications than the bans envisaged in the Proposal.

Therefore, the Dossier Submitters failed to demonstrate that the use of Fluorinated Materials in question in Aerospace and Defence applications poses unacceptable risks to human health or the environment which are not adequately controlled within the meaning of Articles 68 and 69 REACH. Accordingly, fluorinated substances used in A&D applications should be excluded from the scope of the Proposal.

5 Absence of feasible alternatives and substitutions timelines

Equipment and materials in the A&D sector are used in life saving applications and in harsh environments. Therefore, all components in these devices need to be safe, durable, low dielectric and non-reactive across a broad range of temperatures, chemical environments, radiation levels, and other operational conditions (e.g., in engines or critical fluids systems) and extreme environmental exposures. Fluorinated Materials are the only known substances that can meet all these characteristics at required thresholds (on mandatory technical specifications see in section 3 above).

Fluoroplastics such as PTFE, FEP, ETFE, PFPE, PFA, FKM, FFKM, PCTFE and PVDF, provide the unique properties need by critical technical features of materials and equipment used in the A&D sector. These materials could not be substituted by in-kind alternative substances even in the long perspective. Alternative materials should meet all set unique characteristics of fluorinated materials, including:

- High temperatures performance up to 270°C and higher (for certain applications);
- Exposure to low temperatures down to -80°C and below for certain space programmes;
- Good electrical properties; excellent (low) dielectric properties and high arc tracking resistance.
- Chemical resistance to a very broad range of chemicals, in particular to refrigerants, solvents, cleaning agents, pneumatic fluids, oils and fuels used in aircrafts, space and military applications;
- Corrosion resistance;

23 See e.g. Sky-high potential for aircraft recycling, Joanne Perry, Recycling International 2012 March; Aircraft Recycling – A Literature Review, Maaß, Svenja, Hamburg : Aircraft Design and Systems Group (AERO), Department of Automotive and Aeronautical Engineering, Hamburg University of Applied Sciences, 2020.

24 See e.g., in ICAO 2019 Environmental Report.

- Inertness in all environments;
- Flame resistance with a high heat of combustion and limiting O2 Index;
- High mechanical strength combined with low friction / non-adhesive resistance.

Although other materials can demonstrate comparable or even superior performance in single properties, only fluoroplastics have all above characteristics simultaneously (e.g., PTFE vs PEEK, see also in section 3 above).

For instance, fluoroplastics, such as PTFE, FKM, PFA, ETFE, FEP, etc. are indispensable *inter alia* for the insulation of cables, wires and optical fibres largely used in A&D. It is necessary to protect the systems against environmental threats, harsh operating conditions and to prevent electrical leakage, sparks and arcs trekking. The use of fluoropolymers in such electric equipment is driven by their outstanding electrical properties, such as low dielectric constant, flame, crack, and chemical resistance, thereby contributing to the longevity of the overall system. For example, low dielectric loss tangent and high dielectric strength are important detection instruments used in aerospace and military applications. Combined with the high chemical and temperature resistance, and low surface friction characteristics of fluoroplastics such cables are easier to pass through tight conduits.

In the meantime, non-PFAS polymers that can withstand temperatures of 200°C have dielectric constants that are 50% higher (i.e., worse) than those of fluoroplastics. For example, PFA, FEP, and PTFE all have dielectric constants of 2.1, while PEEK, LCP, PPSU, PPS, PI, and PAI have dielectric constants of 3.2, 3.2, 3.2, 3.3, 3.4, and 4.5, respectively. These shortcomings of alternatives are critical for A&D applications such as wire insulation to handle higher voltages, e.g., in aircrafts.

Annex E of Annex XV of the Proposal lists alternative materials for wire and cable insulation. However, all have important weakness and could not properly serve in A&D applications. For example:

- Silicone materials lose their mechanical properties over time and outgas during service, which can lead to delamination and weaknesses in the insulation layer. They cannot achieve the required service life.
- PEEK is not resistant to arc tracking and many chemicals.
- Ethylene Propylene Diene Monomer (EPDM), is not resistant to oils or hydrocarbon fluids.
- Mica is a mineral filler that requires a polymeric matrix to act as a flexible cable insulator.
- Polyvinyl chloride (PVC) has a maximum operating temperature of only around 100°C.
- Polyethylene (PE) has a maximum operating temperature of only around 120°C.
- Ceramic is not flexible and is susceptible to mechanical damage.

As of now, there are no immediate in-kind or functional replacements for current deployments of polymeric PFAS in the A&D sector. The research and development (R&D) process for finding suitable alternatives to PFAS-free materials for aerospace wire insulation is permanently ongoing. However, due to the need for a combination of properties that can only be found in fluoropolymer materials, it is unlikely that alternative materials will be found for all A&D applications within the longest (13.5-year) derogation period of the Proposal (see below).

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Moreover, FKM, VDF-HFP and other fluorinated materials are commonly used to seal components inside specific equipment (actuators, engines, fuel supply or HVAC systems, etc.) or with its external components, i.e., between tubes, pumps, dust filters, solenoids, connectors, etc. They have excellent sealing properties in extreme conditions.

So far, no alternative materials have been found that can meet the required performance of fluoroplastics for sealing and similar uses. None of the investigated potential alternatives (e.g., silicones, PEEK, PI, aramid fibres or mica) can meet all the requirements.[25] PE, LDPE and HDPE plastics are highly flammable, sensitive to stress cracking, and lack resistance to oxidizing agents and certain hydrocarbons and therefore objectively are not able to serve as a substitute for PTFE and other fluoroplastics in the A&D sector.

Many A&D applications rely on PTFE, PFPE, HFE and other fluorocarbons materials (see in Annex II) used as lubricants due to their remarkable resistance to highly acidic conditions (e.g., electrolytes, hydraulic fluids, oils) and fluctuations in temperature. Specifically, PTFE/PFPE greases/lubricants exhibit consistent viscosity across a wide temperature range spanning from -40°C to +60°C. No viable alternatives currently exist that can provide a grease formulation with a low dependence on viscosity-temperature relationship. We are also not aware of active research and development activities to reformulate already approved coatings using PFAS as a solvent for A&D applications.

The same is true for PTFE, FEP, HFE, THV, etc. in numerous tapes, adhesives, structural materials, plating, batteries, capacitors, gaskets, sbarrier films as well as in various types of rubber and thermoplastic (see in Annex II) extensively used in all aircrafts, missiles, satellites, and other A&D applications. A large majority of these are parts of oil, fuel and air systems of engines working at elevated temperatures (above 200°C). These fluorinated materials (incl. FKM, FFKM etc.) must comply with e.g., AMS7287, AMS7257 and AMS3678, have a long history of successful and safe use in commercial and military aircrafts and other applications.

All other potential alternatives, metals, non-PFAS polymers (PEEK, PPS, etc.), and non-PFAS elastomers (e.g., Ethylene Propylene Diene Monomer (EPDM), Hydrogenated Nitrile Butadiene (H-NBR), and Silicone) are not suitable for many critical A&D applications due to either weaker chemical resistance, temperature limitations, and/or mechanical properties. Moreover, these are high performance materials that are likely persistent or very persistent substances similar to fluoropolymers, resulting in substitution of one persistent material with an inferior performing one, leading to increased failure risks, maintenance cycles and generation of higher amounts of environmental waste. These materials could be considered as "*regrettable substitutions*" for fluoroplastic in question as far as A&D industries are concerned.

Hydrofluorocarbons (HFCs) are chemically stable, nonreactive, relatively non-flammable and do not contain chlorine (which can impede performance in certain situations). HFCs can be used in a wide range of applications, including refrigerants, blowing agents in polymer foams, solvents for cleaning plastics and metals and plasma etching. HFCs in propellants was one of the changes made to replace halons in previous environmental regulations.

For instance, since 2010 all new aircrafts have been specifically designed and sized for HFC-134a and HFC-125 hydrofluorocarbon-based refrigerants. As weight/volume is critical for an aircraft/spacecraft, this

[25] For example, different types of silicones can also be detrimental to electronics and cause latent failures due to silicone migration that causes shorts in the printed board assemblies and cause other materials to delaminate from the surfaces of the printed boards.

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optimization is required to meet both size and purpose. Refrigerants are critical for A&D applications. They must operate when flying at 10 km exposing an aircraft to -55°C, must have low flammability properties, be strictly non-toxic and thermally efficient to minimize system size and weight. All currently established refrigerant alternatives fail to meet the critical characteristics above.

The same is true for C5-18-perfluoroalkane, which is a very thermally stable liquid and at the same time has high dielectric strength and resistivity.

It is noteworthy that fluorinated materials have been used and not changed for the history of space flight and are an integral staple of modern aerospace, and if they didn't lend to excellent reliability and long service lives, the industry would use other materials and there would be more interchangeable alternatives already identified and implemented across the industry.

- **Substitution timelines**

For many of the Fluorinated Materials concerned, there are no alternative theoretical material chemistries which could be used as a basis for invention, and the development of a whole new area of chemistry and/or technology will be required.[26] There are also concerns that substitution of certain specific materials would be as large as designing new equipment/systems and would require an uncertain period of time, as highlighted below.

Importantly, in case of substitution by other materials, new equipment or structural material would need to be recertified under all applicable national and international airworthiness standards (e.g., IEC 62990-1,) and quality management systems (including ISOAS9100, ISO 9001 and Nadcap systems - also see in section 3 above). Those processes may take decades, e.g., like in case of Chromium (VI) substances subject to REACH Authorisation.[27]

Each A&D company that designs and incorporates products such as aircraft's engines, radar systems, and missiles is individually accountable for meeting product qualification, validation, and certification criteria, which should adhere to airworthiness regulations or the specifications of defence and space customers. Moreover, even seemingly 'similar' components or hardware used in different systems/models have unique design parameters and performance requirements, driven by the system-level requirements of the final delivered product. These are extremely burdensome and time-consuming processes. Substitution of all PFAS in the A&D sector, in 13.5 years, is not feasible for most SMEs and even large companies from the workload and resource needs points of view.

Given the substantial consequences of any potential failure, it is imperative to approach substitutions of fluorinated materials in the A&D industries with utmost care. These materials have demonstrated remarkable reliability for more than sixty years. A prevailing apprehension pertains to the possibility that SAE, ISO, Nadcap and other standards might need to be revised to accommodate alternative materials which currently fall short in delivering the necessary level of performance. Afterwards, new

[26] For reference, the development of the current fluorocarbons (dichlorodifluoromethane (CCl_2F_2) - refrigerant) started before the World War II, research began to pick up in the 1960s, however specific substances did not go into industrial manufacturing until the 1990s.

[27] For example, A&D companies already spent several decades to develop and implement alternatives to hexavalent chromium (Chromium (VI)). However, there is still no universal replacement for any of these coating and surface treatments (see relevant ADCR Consortium webpage).

materials/instruments/devices would need to be developed (from lab discovery to pilot products), tested and approved by all major aircraft producers [28] and then recertified for both use and mass production. Considering historic practices of the aviation industry, this will take significant time, greatly exceeding the 6.5- or 13.5-years derogation periods envisaged in the Proposal.

Arguably, substitution timeframe is more realistically estimated at 30-years on average for critical civil aviation applications. The substitution period will be even longer for the military and defence sector where technical specifications are often more stringent and difficult to amend for existing long-term production and (intergovernmental) supply contracts.

6 Socio-economic impact of the proposed REACH restriction

Although it is impossible for Honeywell to quantify tonnages and emissions of PFAS used in the A&D sector and perform proper cost-benefits analysis for RMOs envisaged in the Proposal, it is evident that socio-economic impact on the industry and overall society would be disastrous and clearly disproportionate to alleged risks due to PFAS persistency.

In this regard, the use of PFAS in the A&D sector has enabled continued advances in the capability and reliability of aircrafts, military/defence systems and space applications. It has also helped to reduce design and manufacturing costs, operating costs, and emissions from air travel. In addition, the use of PFAS has helped to meet regulatory requirements and industry standards.

Currently, all civil and military aircrafts use a lot of Fluorinated Materials in their design. If the EU restricts PFAS uses, this will mean that no new aircraft could be manufactured, sold, or repaired with PFAS-containing spare parts in the EU. Considering the unrealistic implementation and derogation periods of the Proposal, the PFAS ban on the aircraft industry would be significant given the number of companies and employees directly involved. This would also ultimately jeopardise national security as well as access and safety of air travels. Considering the breadth of industries and economic sectors that depend heavily on air transport, other impacts on the downstream industries and society are difficult to overestimate too. Even if these costs are difficult to credibly quantify at this stage, they are clearly too high and greatly outweigh the alleged benefits of the Risks Management Options (RMO) envisaged in the Proposal.

It is equally important to ensure the availability of spare parts made with PFAS for the maintenance of civil and military aircrafts, which have on average over 40 years of service life. Without a long derogation, A&D sector producers would cease production of spare parts under certain technical specifications. Even if alternative materials are developed, they may not be a direct replacement for PFAS-containing parts in complex A&D equipment/systems resulting in their premature obsolescence of the equipment and/or aircraft. This would have a significant economic, strategic (national security), and environmental impact.

All the above consequences are certainly in conflict with the wider EU industrialisation, competition and international trade policies as well as the objectives of the European Green Deal, REPowerEU, Net Zero Industry Act and other emerging sustainability laws.

[28] I.e., Qualification and/or Validation - reliability testing and validation with producers and/or external testers.

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7 Conclusion

Considering the above, PFAS materials are critical for safety and performance in the A&D sector. This submitted information provides the necessary evidence to support either the complete exclusion of the fluorinated materials from the Proposal or a time-unlimited derogation for the overall A&D sector because there are no available suitable alternatives. Development and approval of such alternatives (if possible) would take an indefinite period of time.

In this respect, the application of the complete ban on PFAS uses in the A&D sector as envisaged in the Proposal, including to respective spare parts and new components of existing equipment and installed systems (e.g., average service life of aircrafts is over 40 years), is disproportionate to the alleged health and environmental risks and would have tremendous consequences and costs for society.

Honeywell requests that use of Fluorinated Materials in Aerospace and Defence applications should be excluded or made subject to a time-unlimited derogation from potential PFAS REACH restrictions.

Annex I – List of acronyms and abbreviations

Annex II – Lists of PFAS substances containing in components and materials used by Honeywell in Aerospace & Defence applications.