EUROMOT
Bruxelles, Belgium

Socioeconomic Impact of the PFAS Restriction on EUROMOT Members

Draft Socioeconomic Impact Report

Client Ref.

Report No. 2023-0465 Rev. 1

Project No. REG50040-001

Rev.	1
Description	Issue 2
Prepared by	Maitheya Riva
Controlled by	Emily Tyrwhitt Jones
Approved by	Paul Goodman
Date	28th August 2023

RINA Tech UK Limited | 1 Springfield Drive, Leatherhead, Surrey, KT22 7AJ, United Kingdom | P. [redacted] | [redacted]@rina.org | www.rina.org
Company No. 07419599 Registered in England and Wales

Note on report approval

The persons identified above have signed off each stage of this report in accordance with RINA's BMS/QA procedure.

Disclaimer

Whilst great care has been taken in the compilation of this report, use of the information contained herein is entirely at the risk of the client or recipient. It does not constitute legal advice and should not be relied upon as such. To the extent permitted by law, RINA Tech UK Limited ("RINA") accepts no responsibility or liability for loss or damage arising out of acting upon or refraining from action as a result of any material in this publication.

FEEDBACK QUESTIONNAIRE

As a valued client your feedback on this project is important to us. We would be grateful if you could spare a few minutes to complete the questionnaire found via the QR code or hyperlink below:

Link: RINA Questionnaire

Thank you.

Issue and Revision Record

Rev.	Description	Prepared by	Controlled by	Approved by	Date
0	Issue 1	Maitheya Riva	Emily Tyrwhitt Jones	Paul Goodman	17th August 2023
1	Issue 2	Maitheya Riva	Emily Tyrwhitt Jones	Paul Goodman	28th August 2023

EXECUTIVE SUMMARY

RINA Tech UK Limited (RINA) was requested by the European Association of Internal Combustion Engine and Alternative Powertrain Manufacturers (EUROMOT) to gather information from members to support the stakeholder engagement currently being undertaken for Per- and Polyfluoroalkyl substances (PFAS) under the REACH restriction proposal. Based on this information, this report provides an assimilation of the socio-economic impact on EUROMOT members' products regarding uses of PFAS.

EUROMOT has represented the key global manufacturers for over 30 years with an annual European turnover of €250 billion. EUROMOT comprises 37 members, with more than 500,000 employees in Europe and 900,000 globally. The technologies enabled by EUROMOT products cover a wide array of fields including construction, mining, marine, agriculture and power distribution to name a few. EUROMOT member products have a fundamental role in the development of infrastructures, and the continuous operation of high reliability applications, such as auxiliary power generators for hospitals and firefighting stations.

Due to the high reliability, and safety requirements of EUROMOT products across long lifespans (up to 40 years for certain applications) currently there are no known alternatives for PFAS due to their unique combination of properties. These critical applications require extensive and specific qualifications to comply to current regulations while ensuring safe operations.

The use of an unsuitable PFAS-free alternative could result in severe health and safety repercussions as EUROMOT applications have to withstand challenging operating environments. EUROMOT members estimate that the use of an alternative with lower performances would result in the reduction of this lifespan of their equipment by up to 90%, potentially resulting in an estimated 1.46 million tonnes a year of additional waste produced. In addition to this, the use of unsuitable substitutes can also potentially result in spillage of hazardous substances which would have long lasting repercussions.

EUROMOT members estimate that at least 13.5 years will be needed from when a viable PFAS-free alternative is made available, to qualify and implement a PFAS-free solution. Due to the uncertainty in the timeline as to when viable alternatives will be identified by EUROMOT's supply chain, it is important that there is a proportionate process to allow derogations to be extended if needed.

If a derogation is not granted, 83% of EUROMOT members estimate they will experience severe impact on their business. As PFAS uses are still under investigation and additional applications are being found, the expected impact is likely to increase and potentially causing the direct loss of 150,000 jobs in the EU, with additional job losses expected in the supply chain.

EUROMOT members estimate that the costs for substitution of all PFAS uses in each company could be up to €20 billion, but there is significant uncertainly for many applications whether there will be a viable technical alternative. Beyond the significant impact on the technical capability PFAS would have on EUROMOT member products, the qualification when there is a viable technical alternative, is estimated to require between 10 to 1000 additional employees per EUROMOT member. Given the known shortage of specialised workforce, it is unlikely to be viable in the available timeframe and the cost of new personnel could be as high as €85 million for a single company which would be unsustainable for many businesses, resulting in the loss of many businesses.

EUROMOT member products have long lifespans and therefore without a derogation which permits the manufacture and use of spares, repairs, and remanufacturing, will result in the early disposal of many products.

EUROMOT suggests changes to the proposed wording for Derogation 6.o (Annex E.2.10), to ensure the critical systems they supply are able to support the critical infrastructures as highlighted by this report. Changes to the original wording are highlighted in bold.

Derogation 6.o “Applications affecting the proper functioning related to the safety and **reliability** of **Internal Combustion Engine systems and Alternative Powertrain systems and affecting the safety of humans or reliability of equipment** until 13.5 years after entry into force”.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

AEM	Association of Equipment Manufacturers
EU	European Union
EV	Electric Vehicle
FTE	Full Time Equivalent
PFAS	Per- and Polyfluoroalkyl substances
R&D	Research and development
RINA	RINA Tech UK Limited

1 INTRODUCTION

RINA Tech UK Limited (RINA) has been requested by EUROMOT to gather information from EUROMOT members to support the stakeholder engagement which is currently being undertaken for per- and polyfluoroalkyl substances (PFAS) under the REACH restriction proposal.[1] This report supports the previous Technical Report[2] and outlines the likely socio-economic impacts of a restriction on the use of PFAS in EUROMOT members products, components, and processes.

Specifically, the report comments on the impact if Derogation 6.o within the Annex XV report adapted as follows

"Applications affecting the proper functioning related to the safety and **reliability** of **Internal Combustion Engine systems and Alternative Powertrain systems and affecting the safety of humans or reliability of equipment** until 13.5 years after entry into force".

This socio-economic analysis compares the currently known PFAS uses as the baseline scenario and the proposed restriction scenario where a suitable derogation is not permitted.

1.1 EUROMOT Members Products Importance to Society

EUROMOT is the **European Association of Internal Combustion Engine and Alternative Powertrain manufacturers**, representing key global manufacturers for over 30 years and comprising of **37 members**. EUROMOT provides an unparalleled heritage and hub of expertise for businesses, authorities, regulators, and public stakeholders worldwide, partnering with major sector associations and institutions for sustainable innovation. Additional information on EUROMOT's mission and membership can be found on their website https://www.euromot.eu/.

EUROMOT member companies design and manufacture safe, reliable, high-quality, and high-performance products. The types of products EUROMOT members produce are a combination of internal combustion engines which rely upon the mechanical power derived from the combustion process in the cylinder to provide the necessary drive, as well as electric and hybrid powered system which are referred to as 'alternative powertrains'. EUROMOT's working groups are pioneering innovations in alternative powertrains including hybrid electric and hydrogen fuel cells enabling the alternative energy transitions.

EUROMOT member companies utilise key technologies to enable operation in a multitude of fields:

- Agricultural, forestry and gardening equipment,
- Auxiliary generators for applications such as hospitals,
- Firefighting equipment, and rescue equipment,
- Marine engines,

[1] Annex XV reporting format 040615 (europa.eu)

[2] 'The impact of a Potential PFAS Restriction on Internal Combustion Engine and Alternative Powertrain Manufacturers', Report number 2023-0368.

- Mining, construction, and heavy industrial equipment,
- Power generation,
- Transport of people, goods and industrial vehicles.

EUROMOT member products are characterised by highly technical and demanding applications and operating environments. Due to this they, have to meet stringent qualification requirements with qualification of alternatives being a highly complex, multi-step, multi-year, and costly challenge.

EUROMOT applications vastly contribute to key areas such as technologies enabling energy-efficiency, green energy transition and applications in social sectors such as transport, construction, and power generation. The industry has a history of innovation and investment in the development of applications that enable EU goals of sustainability.

Reduction of Emissions

EUROMOT's members' engines must comply with EU emissions legislation[3] and so are designed with an array of electrical controls with sensors and actuators to maximise performance with minimum emissions, all of which rely upon PFAS. Modern advanced internal combustion engines and alternative powertrains are in continuous development to meet customer requirements and have played a central role in modern social and economic development. Engine manufacturers have for more than 50 years, invested billions of euros into new technologies that dramatically reduce the environmental impact of using those technologies by reducing emissions and improving engine systems. This has been achieved while also working to minimise operating costs and increase engine efficiency to retain their role as society's most economical and versatile power source.

1.2 Importance of a Derogation to EUROMOT members

EUROMOT members' significantly rely upon PFAS within their product ranges, with over half of responding members stating that 80-100% of their products, components, and manufacturing processes require the functionality that PFAS provides, as outlined in Figure 1. When the secondary impacts are considered, such as associated equipment used as part of a wider system or procedure, are no longer able to rely upon PFAS then this figure will have to consider downstream users and the impact on their application rises even further.

In a single EUROMOT member company, PFAS can be contained within 1,400+ components and products directly, with all other products and components offered by the same company indirectly affected. Therefore, the scale of technical challenges cannot be overstated in its impacts to EUROMOT member companies.

[3] https://single-market-economy.ec.europa.eu/sectors/automotive-industry/environmental-protection/non-road-mobile-machinery_en#:~:text=The%20new%20NRMM%20Regulation,engines%20on%20the%20EU%20market.

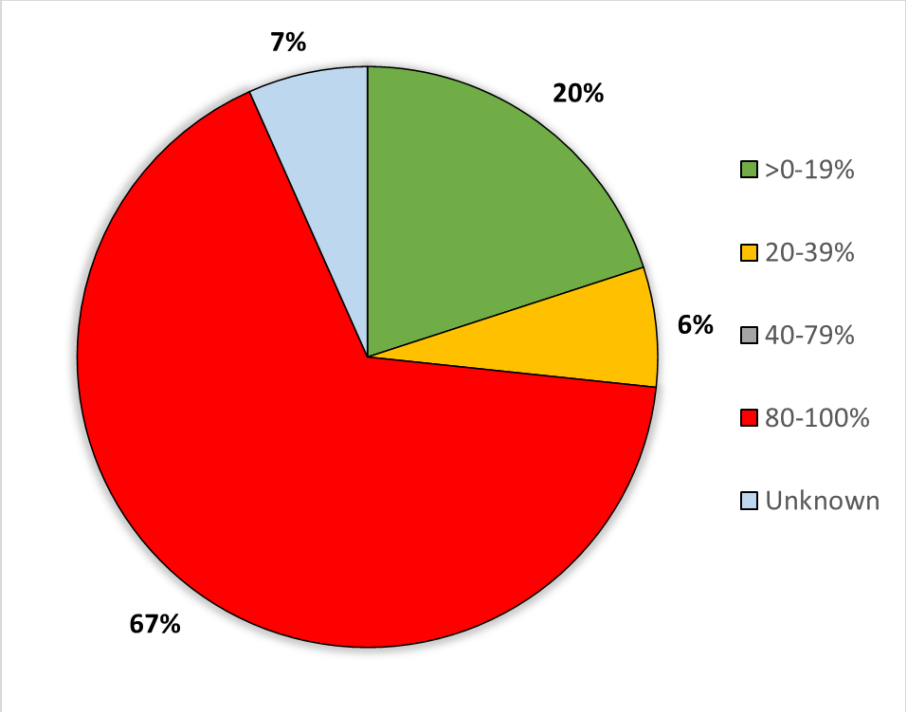

Figure 1 Proportion of products, components and manufacturing processes affected by the PFAS restriction.

1.3 Methodology

A questionnaire was devised and circulated to the EUROMOT membership. The responses from the questionnaire were collated and analysed for common themes, in order to give a representation of the whole membership. RINA reviewed all of the responses and categorised them to enable the results to be summarised here.

The information shared by EUROMOT members in this report provides a snapshot at the point of the information being gathered. It is understood that many EUROMOT members are still identifying the uses of PFAS in their products, this is an ongoing activity which requires collaboration with the supply chain and upstream suppliers in a complex supply chain that be as complex as include 11 layers. Moreover, once PFAS uses are identified, time is required to find suitable PFAS-free alternatives to ensure that they do not contain PFAS themselves or use PFAS in a critical part of their manufacturing process. It is to be expected, therefore, that views will change or develop as more work is undertaken and as new requirements emerge.

For the purpose of this assessment, it has been assumed that there will be a potential PFAS-free alternative for EUROMOT member uses and that the technical characteristic of the engines will not be impacted by a potential alternative. This is unlikely to be the case for all applications, as PFAS substances in many applications do not have a known viable alternative or are at a very early stage in their development. In some cases, substitution may prove to be impossible so that the only option without a derogation, will be to withdraw the product from sale in the EU.

2 IMPACT IDENTIFICATION AND ASSESSMENT

The importance of PFAS for many EUROMOT members cannot be overstated and, in many applications, PFAS are used in light of many other already existing mandatory regulations (e.g. fire protection, energy efficiency requirements, safety standards, emission requirements). PFAS provide a unique set of properties, without which EUROMOT member products, components, and manufacturing processes would no longer function, as all currently known alternatives are unable to offer the necessary technical performance. A differentiated approach to the restriction is essential, with the derogation permitting the suitable time for the development and qualification of alternatives. EUROMOT member products, components and manufacturing processes are essential in achieving broad societal goals such as the **EU Green Deal**, with research aiming at reducing emissions from internal combustion engines and the development of alternative powertrains for alternative energy transitions. Without PFAS these goals cannot be achieved.

2.1 Economic Impact

EUROMOT members significantly contribute to the EU economy, with EUROMOT companies having a combined EU turnover of €250[4] billion in 2022. EUROMOT members place an estimated 53 million engines on the EU market annually, with each engine supporting a critical need.

The sector is global in nature, with the global revenue of EUROMOT members ~€440[4] billion annually, with the global turnover by sector outlined in Figure 2, highlighting the importance to the overall economy.

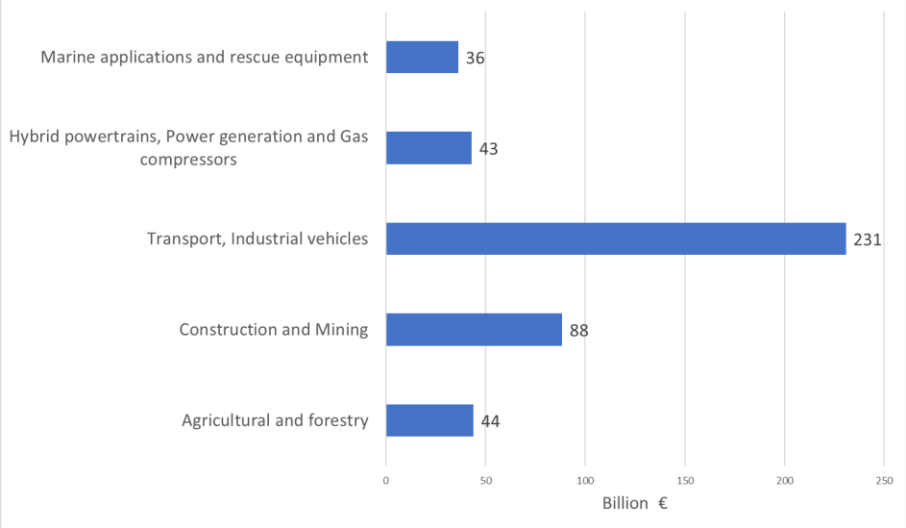

Figure 2 EUROMOT member global turnover by sector.[5]

If the relevant derogation is not granted, all EUROMOT member companies have stated they expect to experience a loss of revenue, with 67% of EUROMOT members surveyed estimate a loss of revenue between 80 to 100%, as outlined in Figure 3. Although some members indicated that a lower proportion

[4] Exchange rate USD dollars to Euro from 19th June 2023.

[5] Estimation based on turnover data from EUROMOT members publicly available information on revenue.

of revenue would be impacted, 83% of members still rated this as a severe impact as seen in Figure 4 as this would significantly affect their business' ability to operate. This would result in the ending of operations in the EU with many job losses.

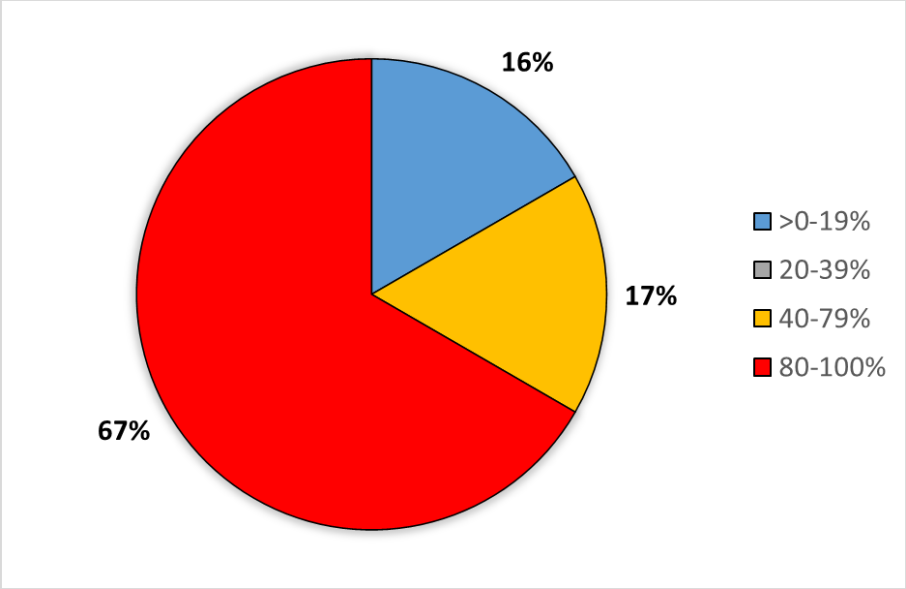

Figure 3 Turnover affected by PFAS restriction.

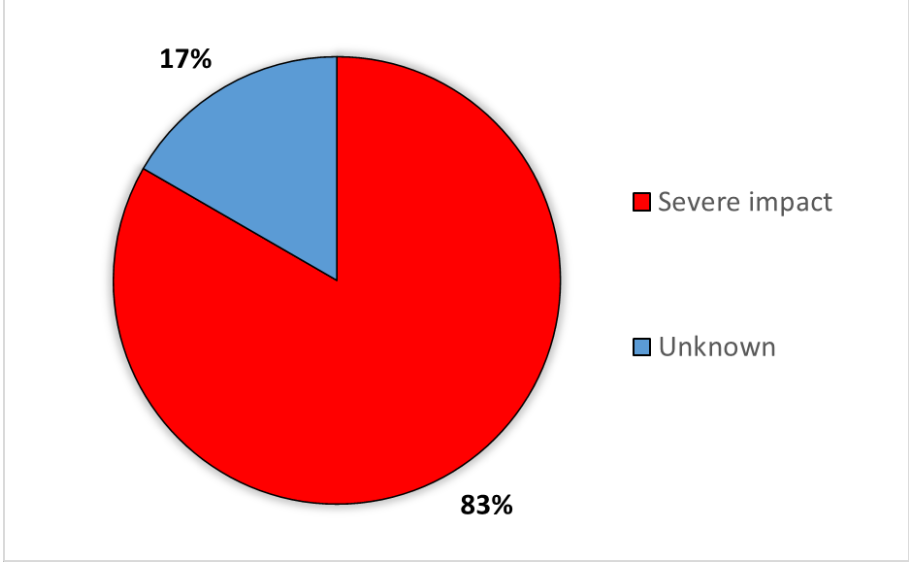

Figure 4 Impact on market share of PFAS restriction.

2.1.1 Cost of Substitution

EUROMOT members utilise PFAS due to its unique technical capability as outlined in the Technical Report.[2] Due to the highly technically demanding end applications EUROMOT members' products are utilised in, the majority of the costs to qualify potential alternatives are technical in nature. Assuming the

presence of viable PFAS-free alternatives, EUROMOT members have estimated the costs of substitutions in a number of cases as outlined in Table 1. The list only reflects a small subset of product types, but can be divided in technical costs, which are directly related to the development and qualification of the products, and organisational costs which include training of personnel and recertification processes. As highlighted in Table 1 the higher estimated costs are related to technical challenges of research, qualification and equipment modification that can be as high as 100% of the entire cost of substitution. For example replacement of emission related components, by different parts to what has been used during engine certification, could require a new engine certification. Where a drop in substitute could be used, it is estimated for products currently on the market that the cost would be up to €20 million per product, depending on the complexity of the product. In such an occurrence the engine would have to be bench tested for recertification reapproval by the competent authority.

EUROMOT members have estimated that to substitute all PFAS substances used in EUROMOT applications would require up to €20 billion per company, of which 20% would be necessary for research, 25% for the qualification process and demonstration and 55% for the modification/redesigns of the equipment. As this estimation includes only technical costs, it is expected that this value is likely to increase when organisational costs are highlighted as well. The overall financial impact to a business depends on the types of products which they manufacture, as well as the number of products affected by the PFAS restriction. Moreover, it is worth considering that EUROMOT is comprised of different sized companies and the cost of substitution will impact smaller companies to a higher degree.

Table 1 Estimated cost of substitution of example EUROMOT applications based on the assumption that PFAS-free alternatives is technically viable.

Product/component/process type	Cost of substitution per company (€M) if alternative is viable	Technical costs	Organisational costs
Cable sheaths	3-6	Research: 20% Qualification/demonstration: 55% Equipment modification: 20%	Recertification of engine: 5%
Tubes and hoses	3-10	Research: 5% Qualification/demonstration: 45-90% Equipment modification: up to 40%	Recertification of engine: 5%
Gasket	5-10	Research: 10% Qualification/demonstration: 90%	-
All O-rings/seals within a company's system	10-20	Research: 5-10% Qualification/demonstration: 45-90% Equipment modification: 5-45%	Recertification of engine: 5%
Refrigerant	>100	Research: 10% Qualification/demonstration: 30% Equipment modification: 50%	Training: 5-10% Recertification of engine: 10%
Emission treatment/aftertreatment system	>100	Research: 20% Qualification/demonstration: 30% Equipment modification: 50%	Training: 10%

2.2 Human Health and Environmental Impact

A substitute material needs to be qualified to ensure the safety and reliability during all foreseeable operation conditions. Moreover, substitutes need to benefit the environment or human heath to not be considered a regrettable substitution and possibly be subjected to further restrictions in the future. To

date there are currently no viable alternatives that would fulfil the necessary technical requirements that PFAS currently meet. As the technical characteristics that make PFAS the material of choice for those application also concerning for the environment and human health an alternative would have to be suitably tested to ensure it would not be a regrettable substitution.

EUROMOT members are not chemical manufacturers, therefore emissions occurring during this process are not known and cannot be controlled by EUROMOT activities. EUROMOT members manufacturing processes comply with the requirements of the Industrial Emissions Directive (2010/75/EU) and all waste is handled according to local waste management regulations. Therefore, the vast majority of PFAS used in Euromot applications is polymeric in form and is less likely to be emitted during use.

The use of unsuitable PFAS-free alternative could cause the release of hazardous substances into the environment due to premature and unforeseeable failure. EUROMOT applications often require the use of fluids to enable operation of specific machine functions, examples of fluid functions are the following:

- Hydraulic fluids, which provide energy transmission, lubrication, heat transfer and contamination control. Fluoropolymers in seals and hoses ensure hydraulic systems maintain pressure and prevent leaks. Sudden pressure losses due to hydraulic hose failures can cause the end use equipment utilising EUROMOT engines to suddenly drop their loads, significantly increasing potential harm to workers.[6]
- Cooling fluids, which ensures that systems work at optimal operating temperature.
- Corrosion protection fluids.
- Lubricants to reduce friction between moving parts.
- Fuels.

The use of those substances is fundamental for the safe and reliable operations of EUROMOT applications. However some of these substances have hazard classification for human exposure and the environment. Therefore, prevention of leaks is a critical requirement for these systems. Fluoropolymer materials have critical characteristics that prevent hoses and seals failure that could lead to leakage of those substances under the demanding operation conditions experienced by EUROMOT member's equipment. Loss of these fluids can also cause engine failure.

For example, diesel engines are designed to run at high temperature for efficiency and cleaner air emissions. To withstand the high operating temperature and maintain compatibility with the fluid's chemistry PFAS materials are required. Internal combustion engines are highly complex devices with a number of different components, as shown in Figure 5. Many parts are deeply embedded in the designs and not easily accessible or are completely not accessible during the operating life of the device. For these purposes, components need to be able to have a combination of technical characteristics to be viable, and therefore rely on PFAS as the only suitable material. Currently there are no known viable alternatives that would adequately satisfy the technical characteristics required and guarantee safety and reliability of the device.

[6] "The essential Societal Benefit of Per-and Polyfluoroalkyl Substances in Non-Road Equipment" Association of Equipment Manufacturers (AEM), https://www.aem.org/

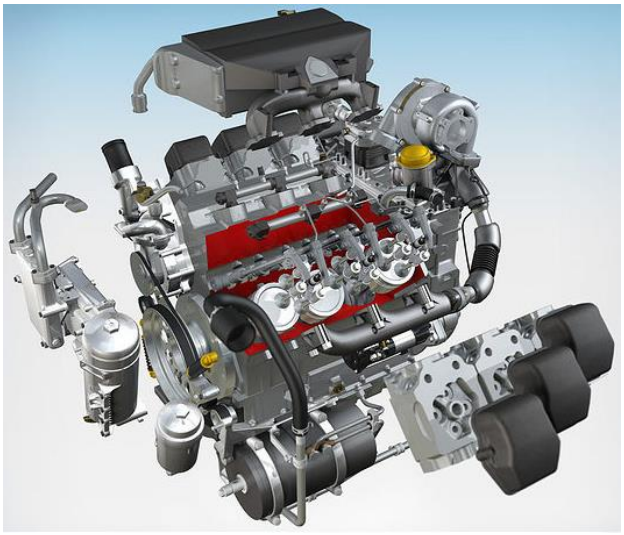

Figure 5 Example of a diesel engine with the image provided by a EUROMOT member.

PFAS are required in a number of different components that are subjected to high temperatures, harsh operating environments, chemical resistance to operating fluids, high vibration resistance. Examples of components that contain PFAS which are commonly used in internal combustion engines are shown in Figure 6. These components are essential for an engine to operate safely and reliably at high temperature in the presence of highly flammable fluids, such as fuels and refrigerants. The lack of reliable components would increase the risk of unexpected catastrophic engine failures and thermal events. Safety of operators would be negatively impacted by such an event with serious repercussions, due to their proximity to the machine.

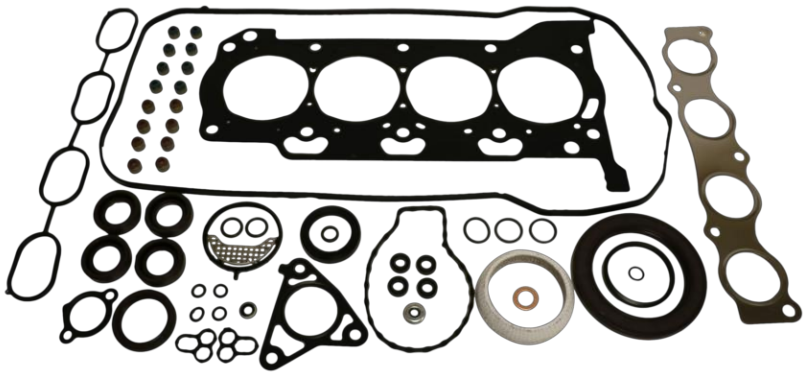

Figure 6 Examples of PFAS gaskets and seals need in a diesel engine with the image provided by a EUROMOT member.

The following examples show critical applications of PFAS components to ensure safe and reliable operating conditions. For example the failure of an O-ring in the fuel injector presented in Figure 7, which highlights the location of the critical PFAS component, can result in the following array of different issues:

- The fuel injector O-ring can dry up or crack and result in the leaking of fuel vapours that will cause the evolution of a fuel smell in the engine bay. As a worst case scenario, the fuel vapour can catch fire causing severe damage and risk to life.

- The O-ring tears or wears out resulting in a leak of fuel in the injector. The presence of highly flammable fuel in this location exposed to high temperature has the potential to result in a safety hazard due to the potential of fire development.
- An injection fuel leak will affect the air-fuel ratio. A change in the engine air-fuel ratio leads to difficulties in starting, misfires, loss in power, loss in acceleration and worse fuel efficiency and in more severe cases stalling.

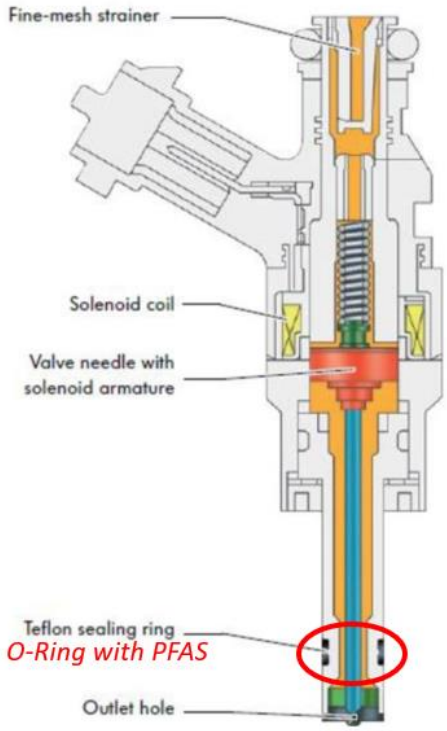

Figure 7 Fuel injector schematics with the image provided by a EUROMOT member.

Engines are designed to operate at high temperatures and as such are subjected to a high degree of fire hazard as they have a high ratio of surfaces exposed to the high temperatures. Thermal events could result in catastrophic failure of the engine, or an engine fire. A sudden increase in the temperature of the engine can occur due to the failure of a head gasket or other temperature sensitive components, or oil contamination and unsuitable lubrication of engine parts. Failure of an engine can result in a violent event (such as if a bearing seizes causing rapidly moving parts to fracture) with a great risk of debris being violently ejected from the engine. Such an event poses a severe hazard to nearby humans and structures that could potentially result in severe to fatal injuries to people in the proximity of the engine.

Flame retardancy

PFAS are used in components such as cables in EUROMOT member products for their flame-retardant properties such that they do not burn or are able to extinguish flames quickly in the event of a fire. This is a particularly important characteristic considering the operating environment of those components, where they are exposed to high temperatures and flammable fluids. In those conditions the development of a fire could have catastrophic repercussions to the surrounding personnel and structures. Fire-retardant properties of PFAS substances are fundamental in preventing the propagation of fire and to

segregate a small fire at one location from reaching flammable fluids at other locations. Figure 8 shows instances where the presence of PFAS materials has enabled fire damage to be circumscribed to localised areas, which is critical in EUROMOT member applications. In both of these examples shown in Figure 8, the fire which burnt a small area has not spread to the rest of the engine or its fuel, due to the properties of the PFAS materials. Moreover, if alternatives were to be developed, they would be required to be extensively tested to ensure safe operation in all of the operational conditions experienced by such equipment.

Equipment operating in hazardous environments, and under severe stress with various workers in the vicinity provide numerous safety challenges. Under those conditions, machine operators require reliable and durable equipment qualified to appropriate safety standards. PFAS substances are fundamental to ensure products are operated safely.

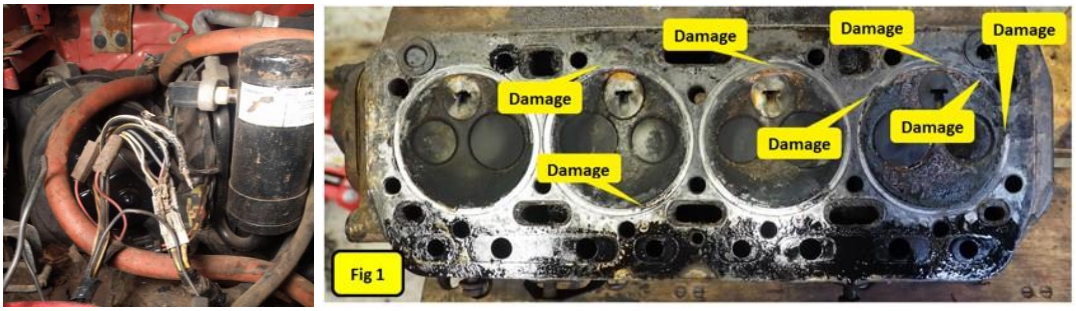

Figure 8 Examples of localised damage due to wire harness failure (left) and engine gasket and seal failure (right) with the image provided by a EUROMOT member.

Electronic parts forming part of the engine control units have to abide by the same requirements of operation conditions to guarantee the appropriate lifespan of the component. Therefore sealings, connectors, circuit boards and several other components, as highlighted in Figure 9, utilise PFAS material to withstand the demanding operating conditions.

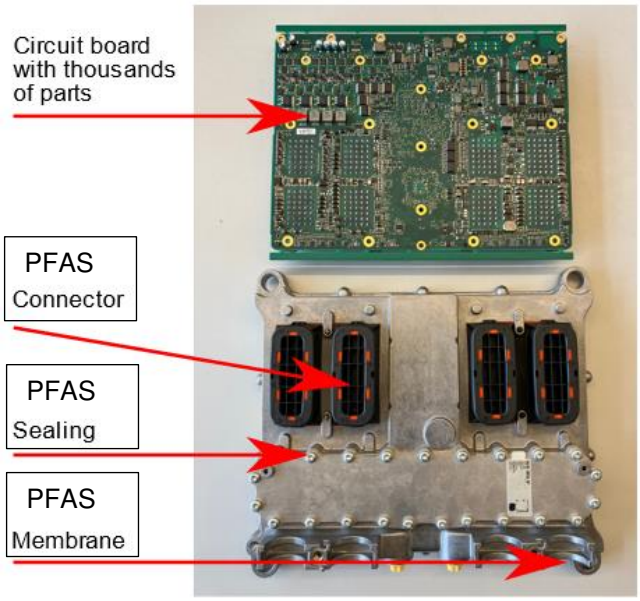

Figure 9 Example of engine control unit with the image provided by a EUROMOT member.

EUROMOT applications are often used in challenging working environments such as remote areas, mining sites (e.g. underground coal mines) or construction areas where there is an increased risk of fire spreading and where the evolution of unexpected fire or loss of power can have critical consequences. In those remote locations intervention of rescue teams is challenging and might take a considerable amount of time, therefore well tested substitutes would be essential but are not currently available as PFAS-free alternatives.

Risk of Explosion

Some PFAS-free refrigerants are flammable substances and there is always a danger of combustion in case of proximity of a thermal event. Due to the nature of EUROMOT products, high temperatures are to be expected during operation and proper precautions have to be used to mitigate the risk of explosion. One fundamental feature to prevent this occurrence is the use of appropriate sealing materials to prevent the contact of the flammable refrigerant with a source of ignition. PFAS substances are used as sealing components for this purpose as they combine thermal resistance and chemical resistance properties with the compatibility with the refrigerating fluid.

F-gases are still of unique functionality not able to be matched by PFAS-free alternatives, mostly due to concerns over the flammability of the alternatives. Even the non-flammable refrigerant carbon dioxide, has the limitation that it has much higher energy consumption and require special design due to high operating and standstill pressures of up to 90 bar. Rather it is not suitable for use in EUROMOT applications.

Electric vehicles (EVs) have drawn increasing worldwide attention as an alternative to internal combustion engine vehicles, owing to their lower energy consumption and almost zero carbon emission. Different from traditional internal combustion engine vehicles, EVs rely even further upon PFAS as they cannot use waste heat from the engine for cabin warming in the cold climate and have to rely on the use of heat transfer fluids. The traditional heating system is much more energy demanding on the battery with a reduction of the milage of up to 50%. A new pump system has been developed to reduce the

battery sacrifice. However, new heat pump systems showed good performance at an ambient temperature above −10°C , but when below −10°C, PFAS-free fluids could not provide sufficient heat for their special refrigerant thermophysical properties. Due to the characteristics operating temperatures, only PFAS fluids are suitable for applications below -10°C. Moreover, although the use of flammable refrigerants is a promising and environmentally friendly solution under ambient conditions, the application of refrigerant fluids in the EV industry is hindered by the potential of refrigerant leakage in the presence of an ignition source resulting in explosion risk. This risk is mitigated by appropriate sealing and segregation of the fluid which is currently possible only with the use of PFAS sealing materials. The use of a non-suitable alternative could not only decrease the efficiency of EVs but increase the risk of explosion with potentially catastrophic repercussion to safety of operators and surrounding activities.[7]

2.2.1 Reduced Lifetime of Products and Components

Due to the fundamental characteristics of the strength of the C-F bond, PFAS have high resistance against harsh chemical conditions, high temperatures, temperature cycles, high vibration, and dirty environments. Details of the technical requirements are outlined in the Technical Report[2]. EUROMOT members have highlighted that in internal combustion engine applications, where sealing materials are in contact with oil and fuel there is requirement to operate for decades. A bench evaluation undertaken by a EUROMOT member testing current PFAS-free alternatives has shown a **decrease in useful life of 90%** compared to PFAS containing parts. Considering that 53 million products are placed on the market every year, if it is assumed that premature failure of the PFAS substitute would result in engine failure in 30% of the cases, this would result in **additional waste of 1.46 million tonnes a year.**[8]

EUROMOT members products have an expected life up to 40+ years in remote locations and challenging environments where substitutions and repairs are not readily available or viable. Moreover, in remote application or harsh environments substitution of components cannot be performed on site and the equipment needs to be transported back to the manufacturing facility for disassembly and maintenance and then returned to site. This process causes significant disruption of operations and loss of productivity. The significantly reduced lifetime of critical components would impact the continuity of business services and would result in a significant reduction in safety and reliability of the equipment. As such current PFAS-free materials and components cannot be considered as viable alternatives.

2.2.2 End-of-life and Waste considerations

Due to the nature of the products, disposal is handled as dedicated waste according to local waste provisions or the products are returned to the manufacturers for remanufacturing. It is however noted

[7] Li K, Wang J, Luo S, Wang Z, Zhou X, Fang J, Su L, Tu R. 2020 Experimental investigation on combustion characteristics of flammable refrigerant R290/R1234yf leakage from heat pump system for electric vehicles. R. Soc. Open Sci. 7: 191478. http://dx.doi.org/10.1098/rsos.191478

[8] It is assumed that the number of total engine failures derived from the failure of a PFAS-free substitute is 30% of the total average engine weight (101kg). This is due to the complexity of EUROMOT assemblies and PFAS components often being deeply embedded within the device and disassembly is challenging if not impossible for particularly sophisticated subassemblies. If a derogation was not to be granted such equipment would have a shorter life and would result in the disposal of the entire equipment where repair was not viable.

Therefore the total additional waste resulting from the of decrease in useful life is given by:

The number of products placed on the market by EUROMOT members x estimated average weight of a product x the reduction of useful life x estimated fraction of total engine failures.

that EU recyclers are not obliged to monitor PFAS emissions[9], but recently studies have been published that show that no harmful PFAS emissions occur with well-run incinerators.[10] Electrical and Electronic Equipment is regulated by the Waste Electrical and Electronic Equipment Directive (2012/19/EU), which recyclers are obliged to ensure that there are no emissions of polychlorinated biphenyls, furans, and other toxic by-products. As such the conditions required to achieve this should also completely destroy PFAS. Additionally, some processes to make materials for end-products and for product disposal at end of life might be in scope of the Industrial Emission Directive (2010/75/EU), The applicable legislation is the IED which imposes strict limits on emissions of toxic by-products such as furans and dioxins. Recyclers use high temperature conditions in their processes to destroy these substances and these conditions will also destroy any PFAS emissions.

2.2.3 Spare Parts

Spare parts are essential for maintenance and repair of existing devices and equipment and need to be readily available to ensure that the equipment can quickly be repaired, and the function returned to the equipment. If the restriction as proposed is adopted, with the current definition of “placing on the market” under REACH this would not be possible as any supply or making available to a third party, and hence any resale or lease, for example, is considered “placing on the market” under REACH and PFAS-containing parts could not be supplied.

There are a number of niche applications in EUROMOT member products, such as mining equipment or equipment destined for the use in nuclear plants, that require specific requirements due to the specificity of their operating characteristics and environments. If any single EUROMOT product, were no longer be able to be sold, the unique functionality would be lost and pose a detrimental impact to society. As a result, transport, construction, manufacturing and mining operations in the EU would be severely curtailed when equipment stops working and cannot be repaired due to a lack of spare parts and no replacement equipment available. This is likely to cost the EU’s economy many billions in the medium term until substitute end-products are available. This is discussed further under the Social Impacts, section 2.4 below.

Even though the systems are designed with the intention to last the lifetime of the equipment, in case of a failure, spare parts need to be available for the entirety of lifetime of the equipment, with examples of product equipment lifetimes outlined in Table 2. Due to the wear on gaskets, seals, hoses and hose assemblies these parts are commonly sold as spare parts with 5% of engines requiring hose replaced per year. The down time for the maintenance can vary between a few hours for parts that are readily available on site, and to up to two years for custom design parts that require ad hoc manufacturing. Without spare parts being available, usually weighing only a few hundred grams, the entire equipment would need to be disposed of creating waste of several tonnes.

Assuming that PFAS-free alternatives are readily available on the market, which is not currently the case, it is likely that in many applications these will not be a drop-in replacement for the PFAS on a 1:1 basis due to different properties such as chemical inertness, tightness, and functionality. Systems will therefore need to be redesigned to permit the use of PFAS-free alternatives. It is expected that for

[9] Two seconds at 1000°C should be enough to destroy PFAS, according to https://www.epa.gov/sites/default/files/2019-09/documents/technical_brief_pfas_incineration_ioaa_approved_final_july_2019.pdf . Most steel and non-ferrous smelters operate at much higher temperature.

[10] Aleksando, K., Gehrmann, H-J., Hauser, M., Matzing, H., Pigeon, D., Stapf, D., Wexler, M. (2019). Waste Incineration of Polytetrafluoroethylene to Evaluate Potential Formation of PFAS in Flue Gas and Waste incineration of polytetrafluoroethylene to evaluate potential formation of PFAS in flue gas, A. Krasimir et.al. Chemosphere 226 (2019) 898 – 906.

EUROMOT members this would require more than 13.5 years and would be an extremely costly and onerous activity. Moreover it is anticipated that the cost of transition towards PFAS-free alternatives would be higher than procurement of a new system although the exact price differences were unable to be calculated.

It is therefore clear that without the general consideration to permit the use of PFAS in these applications, this will cause the premature end-of-life and scrappage of products which otherwise could be serviced and maintained in service with PFAS-containing parts. For products where service life of over 40 years is not uncommon, it is important that at least this length of time is permitted after product or application specific derogations expire.

Table 2 Average lifespan of machinery in different end sectors.

Sector	Lifespan of machinery
Material handling / Construction / Excavators	~20 000 working hours
Mining trucks / Excavators	Between 45 000 and 60 000 working hours
Rail	~ 30 years
Mobile cranes	~ 30 years

2.3 Remanufacturing

Due to the high specificity and intrinsic value of EUROMOT members products, end of life equipment undergoes a process of refurbishing to be placed on the market again. The market for refurbished good is not only environmentally more sustainable but it also valued €26.1 billion a year, constituting 2% of the entire manufacturing sector in Europe. During remanufacturing, the product is completely refurbished to new part quality, while reusing the available part with as little processing as possible, as highlighted in an example of reuse rate in Table 3. This process is different from recycling where the materials are extracted by energy intensive processes, for example metal is remelted.

Table 3 Example of reuse rate.[11]

Component	Raw material	Weight (Kg)	Weight by percentage of the overall equipment	Reuse rate
Crankcase	Lamellar graphite cast iron	223.0	23%	78%
Crankshaft	Micro-alloyed pearlitic steel	84.4	9%	75%
Flywheel housing	Ductile iron	62.4	7%	85%
Oil sump	Near eutectic cast aluminium alloy	13.0	1%	81%

[11] Whitepaper "Remanufacturing, Second life for used products" Liebherr.

Component	Raw material	Weight (Kg)	Weight by percentage of the overall equipment	Reuse rate
Control Unit	Die-cast aluminium	5.47	<1%	75%
Diesel engine, total		950	Approx. 41%	

Remanufacturing processes result in a significant reduction in energy consumption and carbon dioxide emission, however this is only possible if there is no change in the design of the product or the materials that are used. Considerable changes in the designs, such as the unavailability of PFAS components, would require the redesign of the assembly. As discussed previously in this report and in the Technical report, retrofitting of existing assemblies would not be a viable alternative and severely impact the remanufacturing market. This will likely have a more severe impact on niche applications which are highly sophisticated and require long times to both develop and qualify. Due to the specificity of those applications and the complexity of those designs they are costly as well as difficult to source. For those reasons end users rely on the longevity of those equipment and their availability on the remanufacturing market.

2.4 Social Impact

Currently PFAS are key enablers of many EUROMOT member products, components, and in manufacturing processes. Without a derogation and considerations towards spare part availability for products brought to the market before restriction comes into force, there will be a significant impact on the employment of EUROMOT members, its supply chain, the operators' facilities and the ability to undertake new innovations. Examples of critical applications that would have severe impact on society if a derogation was not to be granted are outlined below.

Emergency generators in hospitals

There are 15,000 public hospitals in the EU and it is expected that most have at least one emergency generator. All existing stock in use will contain PFAS parts, based on EUROMOT's technical report. Emergency generators should be regularly tested and any faulty parts replaced. In case of a failure, faulty parts would need replacement, however if the part was to contain PFAS, it would not be available anymore. As critical devices, emergency generators have to undergo extensive qualification, therefore if a derogation was not to granted this application would not be able to continue in EU and it could take years to provide an alternative solution. If 5% of the generators currently in use develop faults each year that cannot be fixed (this is considering a conservative assumption that a typical lifetime before a fault occurs is 20 years, while is likely to be a shorter timeframe). This would result in an increasing number of faults with 5% of hospitals after the first year, 10% after the second, etc., hospitals will be without emergency generators.

If it is assumed that 10% of the hospitals experiencing a fault in their emergency power generators, experience a power cut before the emergency generator is replaced, two possible scenarios are likely to occur:

- The hospital is no longer able to carry out operations or provide appropriate support to critical emergency patients;

- And more likely, critical patients on life support systems and under operations during the power cut are likely to die.

Considering likely statistics there are at least up to 10 patients that would fit those categories in a hospital at any given time, which would be 1125 patients with a conservative estimation, and it is likely that some of those patients would pass away due to interruption of power supply[12]. It is not possible to predict this with accuracy as there are many factors to consider including the human factor, however this is a likely outcome to be considered.

EU construction industry

The EU construction industry is currently estimated to be worth €850 billion based on the 5% of an estimated GDP of €17 trillion [13]. The employment of this sector is estimated to be of 18 million jobs[14]. This industry relies on construction machinery that contains EUROMOT members products that include PFAS components. A PFAS restriction without a derogation will likely result in the following possible scenario:

- If equipment was to develop fault, spare parts for repair would not be available if they contain PFAS, the same issue would be present if scheduled maintenance is performed and PFAS components have to be replaced as part of the maintenance process. One machine not available could result in interruption of activities in the construction site. If it is assumed that each year 5% of equipment would require maintenance that includes PFAS components, if a derogation was not granted, in just two years it would result in 10% of the machines not working. If after just two years 10% of machines are not working this could reduce construction work by up to this percentage. It has also to be considered that spare machines for those applications might not exist as time for development is estimated to be several years. This could potentially result in a loss of about 5% a year in construction not being possible in this sector which under current estimations would be a loss of €42.5 billion to the EU's economy and 900,000 lost jobs, with the loss in revenue to increase for every year of impact.
- The unavailability of construction equipment would have severe impact on the development of new infrastructures such as roads, airports, ports, utilities, as well as private building sites for private homes. In addition, the unavailability of equipment will have repercussion on operations of maintenance of existing structures such as bridges and highways, that can be undertaken. If those activities were to become more sporadic it would result in safety concern of reliability and stability of those structures.

2.4.1 Employment Effects

EUROMOT members employ a ~900,000 strong workforce globally, of which 500,000 are in Europe. The sector is continually growing and there is an increasing need for highly skilled employees, as showcased in Figure 10 and Figure 11. Multiple EUROMOT companies have highlighted that if a derogation was not granted, the impact on jobs would be severe with an expected 4,050 direct job losses (on average) for each EUROMOT member. It is therefore expected that if a derogation was not to be

[12] Considering the number of hospital beds in EU is of 5 beds every 1000 inhabitants, with a population of 448.4 million people in 2023, it is expected that the average number of beds per hospital is going to be 150.

[13] Europe GDP statistics.

[14] Internal Market, Industry, Entrepreneurship and SMEs.

granted, for the whole of EUROMOT the cumulative job loss would be ~150,000 or 30% of the total EUROMOT employment in Europe. This estimation does not take into account the indirect job loss that would be impacted in EUROMOT member's supply chains.

The benefits EUROMOT members bring to the EU economy are likely to be even more impacted than these figures as the extent of the restriction is not known at this stage and additional challenges might be highlighted at a later stage.

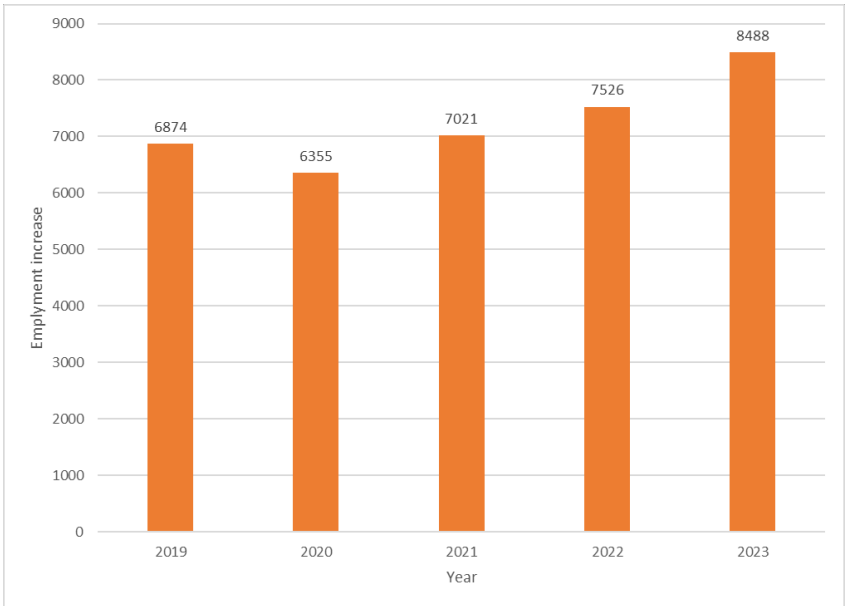

Figure 10 EUROMOT member employing rate trend in the last 5 years.[15]

The majority of EUROMOT members would need to hire additional staff to be able to investigate potential alternatives due to the significant number of parts affected. The median number of additional staff expected by EUROMOT members is 28 full time equivalents (FTE), however this ranges from 10 to 1000 FTEs in a single company. These additional employees would need a high degree of training and experience to be able to progress the qualification of PFAS-free alternatives in EUROMOT member products.

There is already industry recognition that in the automotive sector, that there is a significant skills shortage and finding appropriately experienced and qualified staff is challenging. This concern is reflected in EUROMOT member companies with the majority of the members, 67%, raising concerns on the unlikeliness of finding suitable personnel to be able to adequately resource the qualification of PFAS-free alternatives, as shown in Figure 11. It is therefore expected that research and development would have to be halted, impacting the innovations of EUROMOT member products as outlined in Section 2.3.3.

[15] Employment data provided by one EUROMOT member.

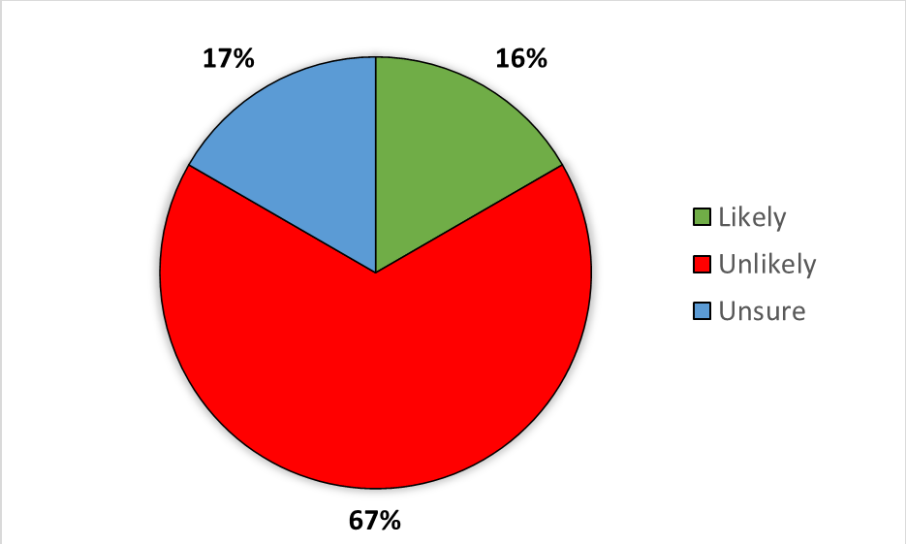

Figure 11 Likelihood of finding suitably qualified personnel for PFAS-free qualification.

Additional personnel cost is expected to be between €60,000 and €85,000 per year per employee, which for a company that requires an additional 1000 employees would result in an investment of up to €85 million per year. This is a considerable investment for EUROMOT members and in particular for smaller companies the cost of personnel required might surpass the annual revenue. If this was the case this would be unsustainable for business.

2.4.2 Supply Chain Effects

The supply chain of EUROMOT members is highly complex, with the supply chain being up to 11 layer deep, and includes thousands of articles containing PFAS from many different suppliers. The complexity of the supply chain introduces a significant challenge in the identification of PFAS and their uses in EUROMOT products, as discussed in the Technical Report[2].

Due to the unprecedented large scope of the proposed restriction, the current disclosure requirements via safety data sheets and Substance of Very High Concern information are insufficient to build the basis for identification and evaluation of all relevant PFAS uses. Where the presence of PFAS is in articles PFAS need not, in general, be declared to a manufacturer. This is especially challenging when seeking alternatives across the global market, as it can be difficult to ensure that the alternatives being researched are not themselves PFAS. It will take time and resource to work through supply chains to discover precisely what substance is being used in many cases, and further time to establish what could be used as alternatives. Many respondents cannot quantify how long this will take.

It may be the case that essential PFAS uses will be identified late in the process. Due to these factors, it is essential that a simple formal process for new derogations to be sought after the publication of the restriction is included in the restriction legislation.

In addition due to the highly critical applications and challenging operating environments, EUROMOT members have supplier qualification requirements if new suppliers need to be introduced due the use of PFAS-free alternatives. this could add up a significant amount of time to the overall qualification and substitution process.

Notwithstanding these challenges there is also the interplaying consideration that many supply chains are making the choice to exit the PFAS market, such as 3M[16], prior to the regulatory obligations. For EUROMOT members this poses a significant challenge as the qualification timeframes for their products, components and manufacturing processes are lengthy, as outlined in the Technical Report[2]. As such this could cause considerable interruption of the supply of affected products and processes, or the delay of other equipment as resource is diverted to the qualification of alternatives on affected items. The effort in investigating PFAS presence is affecting the entirety of EUROMOTs' supply chain, effecting smaller suppliers to a greater degree due to the need to invest in a considerable amount of resources in engaging with their supply chains.

2.4.3 Innovation

EUROMOT members are characterised by a long history of innovative products and technological development. Investments in research and development (R&D) can have a very long-term horizon with timeframes of years or decades depending on the type of product. This is in contrast with the fast pace of EU chemical policy as it introduces new requirements which impact R&D programs and increases the risk for long term investment, therefore reducing the capability of companies to develop and bring to the market new technologies that offer benefits to society.

Any restriction entering into force during the R&D phase can force companies to stop the development, with more than **13.5 years** expected to be needed to undertake the necessary qualification, specific testing related to the component type, emission requirements, and registrations. The exact timeframe is dependent on the product in question but there is the general trend that the closer to the end of the R&D, the worse this impact is. In a similar way, any restriction entering into force during the sales of a model, would halt the placing on the market of such models as redesigning existing models is not an option.

EUROMOT members are involved in the development of increasingly efficient internal combustion engines and alternative power trains for energy transition and EV. Those goals would not be achievable without the use of PFAS substances. Due to the large scale of the PFAS restriction impact, EUROMOT members expect that the innovations relating to product development will be delayed or postponed. This is due to the need for very significant investment and skilled workforce dedicated to PFAS substitution which will require the diversion of resources towards activities to replace substances in devices, both in terms of funding and allocation of limited-availability and suitably qualified personnel to work on such devices.

[16] 3M to Exit PFAS Manufacturing by the End of 2025 - Dec 20, 2022

RINA Tech UK Limited | 1 Springfield Drive, Leatherhead, Surrey, KT22 7AJ, United Kingdom | P. [redacted] | Company No. 07419599
[redacted]@rina.org | www.rina.org