PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) REGULATORY PRESSURE AND ITS IMPACTS ON KEY APPLICATIONS WITHIN AIRBUS SE SUPPLY CHAIN

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A THEMATIC PAPER SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF MANAGEMENT COLLEGE OF MANAGEMENT MAHIDOL UNIVERSITY 2023

Thematic paper
entitled

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) REGULATORY PRESSURE AND ITS IMPACTS ON KEY APPLICATIONS WITHIN AIRBUS SE SUPPLY CHAIN

was submitted to the College of Management, Mahidol University
for the degree of Master of Management
on
May 2, 2023

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ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to those who have always supported and encouraged me in accomplishing this thematic paper. Firstly, I am thankful for the guidance and suggestions provided by my advisor, Assoc. Prof. Prattana Punnakitikashem, Ph.D., during my research in France. Her encouragement and advice were essential in carrying out the research in the right direction.

Secondly, I would like to thank José Miguel De la Viuda Sainz, Isabelle Delay Saunders, Julien Lao, and Audrey Quideau, the project managers of Airbus SE's BX – Strategy, Business Planning & Performance Department, who closely collaborated with my team throughout the two-month company project period.

Thirdly, I am grateful for the valuable memories and experiences shared with my international friends at Toulouse School of Management, Université Toulouse Capitole I, during my seven-month stay in Toulouse, France.

Finally, I owe my inspiration to my beloved family for the opportunity to pursue the double master's degree at the College of Management, Mahidol University, and Toulouse School of Management, Université Toulouse Capitole I. I am also grateful for the endless support and encouragement of my family, friends, and colleagues.

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ABSTRACT

This paper examines the impacts of regulatory pressure related to per- and polyfluoroalkyl substances (PFAS) on lubricants, metal plating, electronics and firefighting foam which are key applications within the supply chain of Airbus SE, a leading aircraft manufacturer. PFAS is one of the strongest compounds in chemistry and is used in various commercial and industrial applications, including the aerospace industry, due to their unique characteristics such as heat, fire, and corrosion tolerance. However, PFAS have been related to irreversible health and environmental exposure and accumulation, leading to increased regulatory scrutiny and pressure throughout the European Union (EU) and the United States (US). The study identifies key regulations related to PFAS in the EU and the US. The paper also assesses the impacts of PFAS regulations on Airbus SE supply chain by analyzing the implications of PFAS found in the products or services of key applications of the company and evaluating the likelihood of supply chain risk in Airbus SE's suppliers. The findings highlight the need for greater risk management, supplier engagement, and innovation to mitigate the impacts of PFAS regulations and ensure the sustainability of the aerospace industry. The paper provides recommendations for Airbus SE to enhance the corroboration with its suppliers and stakeholders and minimize the supply chain risks associated with PFAS regulations.

KEY WORDS: Airbus, PFAS, per- and polyfluoroalkyl substances, supply chain,
64 pages

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CHAPTER I
INTRODUCTION

1.1 Background

Since the 1940s, products containing per- and polyfluoroalkyl substances (PFAS) have been widely made and used for their ability to repel grease, water, and dirt in many industries. PFAS are man-made chemicals, and they can be found in firefighting foam, aerospace technologies and consumer products. The substances are called 'forever chemicals' because they are one of the strongest compounds in chemistry and persistent leading to irreversible environmental exposure and accumulation. Their persistency and stability in hostile environment made PFAS desirable in the aerospace, construction, and electronics industries. Nevertheless, the use of firefighting foams and the careless discharge of PFAS from industrial sites has resulted in wide-ranging PFAS contamination in the local and global water supply. If dispersed through air and water in the environment, some of them can bioaccumulate in human and animal body. People are exposed to PFAS through almost all consumer products, including in paper and cardboard food packaging (e.g. food containers, plastic bags, pizza boxes etc.), non-stick cookware, textiles (e.g. waterproof clothing and equipment, mattresses, carpets etc.), cosmetics (e.g. hair conditioner, sunscreen foundation cream etc., electronics (e.g. smartphones) (Glüge, Scheringer, & Goldenman, 2020) as shown in Figure 1.1.

Figure 1.1 PFAS are found in almost all consumer products

Due to their bio accumulative nature and environmental persistence, since the early 2000s, there are several concerns in the global community about the long-term effect of PFAS exposure on human health. Currently, PFAS health effects are debated, but there are growing evidence of, for example, foetal developmental issues, cancers, immune system disruption, resistance to vaccines, thyroid disease, impaired fertility (Saikat, Kreis, Stephen, & Robie, 2013; Rappazzo, Coffman, & Hines, 2017).Without taking any action, their concentrations will continue to increase, and their toxic and polluting effects will be difficult to reverse. A hazard assessment for perfluorooctane sulfonic (PFOS) and related chemical products was released by the United Nations Organization of Economic Corporation and Development (OECD) in 2002, which summarized that PFOS is "persistent, bioaccumulative, and toxic to mammalian species," resulting in liver and thyroid tumors in rats (Organisation for Economic Co-operation and Development (OECD), 2002). Also, it is said that PFOS exposure was epidemiologically correlated to bladder cancer in humans (Organisation for Economic Co-operation and Development (OECD), 2002).

Consequently, laws, and regulations have been implemented to enhance circularity in the context of a toxic-free environment. In European Union (EU), there is a high level of regulatory initiatives. For instance, The Stockholm Convention on Persistent Organic Pollutants (POPs) is widely regarded as a significant achievement in international environmental policy. The convention was adopted in 2001 and entered into force in 2004. (Stockholm Convention, 2019) Additionally, in 2006, the European Parliament and the Council of the European Union (EU) declared that "PFOS fulfil the criteria for classification as a very persistent, very bioaccumulative and toxic" chemical (The European Parliament and The Council of European Union, 2006). Consequently, the EU remarked further that "… an unacceptable risk to human health and the environment arises from the manufacture, use or placing on the market of PFOA, its salts and PFOA-related substances" as part of the Registration, Evaluation, Authrorization, and Restriction of Chemicals (REACH) regulation (Juncker, 2017). According to the European Commission concludes the total number of sites emitting PFAS could be 100,000 or more for the European Economic Area (EEA) as of 2020 (Goldenman, et al., 2019). This evolving regulatory landscape puts more pressure on industry, multiplying the number of targeted substances. Also, in the future, there will

be more proposed restriction on manufacturers placing on the market and the use of PFAS in Europe and the US will be tightened up and controlled.

Accordingly, these regulations and policies have an impact on airline industry and its supply chain because the high cost of PFAS remediation and monitoring efforts significantly challenging. PFAS are commonly used in the aerospace industry for their resistance to heat, fire, and corrosion, and can be found in a variety of products, including hydraulic fluids, lubricants, adhesives, and coatings. PFAS contamination can be widespread and persistent, which can make cleanup and monitoring efforts difficult and expensive.

In addition, regulations and policies related to PFAS can require the airline industry to implement new measures to reduce or eliminate the use of PFAS, which can also be costly. For example, airlines may need to invest in new materials or substances that are less harmful to the environment and human health, which can involve significant research and development costs.

Furthermore, airlines may need to work with their suppliers to ensure that the products they use are PFAS-free, which can require additional resources and investment. The cost of compliance with PFAS regulations and policies can also be passed down the supply chain, potentially impacting the cost of products and services across the industry. Overall, the airline industry will need to adapt to new regulations and policies related to PFAS, which involve significantly financial changes to their operations and supply chain.

Apart from regulatory pressure, there are pollution and contamination incidents leading to thousands of court cases claiming high compensation and remediation costs (Memoranda, 2023) for many chemical manufacturers and suppliers such as 3M (Wallender, Bloomberg Law, 2022; Jackson, 2022; Maher & Tita, 2022) and DuPont (Amarelo, 2021; Maher & Tita, 2022). This leads to, additionally, pressure from investors for chemical manufacturers and suppliers to declare the use of PFAS and propose plans to avoid the impact that the regulations and other pressures around PFAS has on the market soon.

Airbus SE, formerly known as Airbus Group, is a multinational aircraft manufacturer and assembly company headquartered in Toulouse, France. The company designs, manufactures, and sells a wide range of commercial and military aircraft,

including the popular A320, A330, and A350 families of commercial airliners, as well as various military aircraft such as the A400M transport and the Eurofighter Typhoon. Airbus SE is one of the world's largest aircraft manufacturers, with production facilities and offices located in various countries around the world.

Figure 1.2 A350-900 and A350-1000 are among the commercial aircraft models from Airbus SE

Airbus SE has identified several Top Business Objectives (TBOs) that address sustainability across the organization. These TBOs are focused on reducing the company's environmental impact and increasing its social responsibility, while also improving its financial performance. Here are some of the key TBOs: (a) climate change, (b) airports airlines and passengers, (c) resources and materials, and (d) transparency.

According to (c) resources and materials, Airbus SE is aware of the PFAS regulatory growing pressure and would like to minimize the impact on sustainability attributable to the whole Airbus SE supply chain mainly using PFAS which are lubricants, metal plating, electronics, and firefighting foam. This study will focus on how to support the company's product and environmental strategy by aiming at chemical regulations and restrictions consequences linked to PFAS.

1.2 Problem Statement

PFAS are a group of man-made chemicals that have been widely used in various industrial and consumer products due to their unique properties such as water and stain resistance, non-stick properties, and fire resistance. However, PFAS have been found to be persistent in the environment, accumulate in living organisms, and potentially harmful to human health.

In recent years, many countries have implemented regulations and restrictions on the use of PFAS due to their environmental and health concerns. The growing pressure of PFAS regulations can have a significant impact on the entire Airbus SE supply chain, as PFAS are used in various products and processes, including lubricants, metal plating, electronics, firefighting foam.

If regulatory restrictions on PFAS become stricter or new regulations are implemented, Airbus SE may face challenges in sourcing alternative materials and processes that meet its safety, quality, and performance requirements. This can result in higher costs and longer lead times, which can affect the company's competitiveness and profitability.

Moreover, PFAS regulations can also impact Airbus SE's suppliers, as they may need to adjust their production processes and sourcing strategies to comply with new regulations. This can lead to supply chain disruptions and potential delays in the delivery of critical components and materials. To mitigate the impact of PFAS regulations on its supply chain, Airbus SE can proactively engage with its suppliers, regulators, and other stakeholders to understand the latest regulatory requirements and develop a comprehensive strategy to reduce or eliminate the use of PFAS in its products and processes. The company can also promote innovation and collaboration to identify new, sustainable materials and processes that meet its safety, quality, and performance requirements while minimizing the environmental and health impacts It is necessary to study the impacts from PFAS regulatory pressure on key application within Airbus SE supply chain in order to recommend the company to position itself by minimizing environmental effects and supply chain risk from the impacts of PFAS regulations.

1.3 Research Question

How PFAS regulations pressure has an impact on key applications within Airbus SE supply chain?

1.4 Research Objectives

This study seeks to understand the impacts that regulations and other pressures around PFAS have on key applications within the Airbus SE supply chain, in particular lubricants, metal plating, electronics, and firefighting foam. The objectives are as follows:

1. To explore existing and upcoming PFAS regulations and restrictions
2. To assess the potential impact of PFAS on the Airbus SE supply chain's key applications by using strategic risk mapping
3. To provide recommendations to Airbus SE for minimizing environmental impact and supply chain risk

1.5 Research Scope

This consulting internship project is a project of Toulouse School of Management, Université Toulouse Capitole I, which cooperates with Airbus SE as a part of UE9 International Project Management & Consulting Projects course in Master 2 International Management. The consulting assignment took place in Toulouse, France where Airbus SE Headquarters are located. The scope of supplier data collected on PFAS use are global main supplier lists for each key application within Airbus SE supply chain which are lubricants, metal plating, electronics and firefighting foam. The time of data collection is from 3 January 2023 to 31 March 2023. The goal of the study is that it will be used in BX - Strategy, Business Planning & Performance Department to support product and environmental strategy for Airbus SE in France but it can vary depending on Airbus SE's specific priorities.

1.6 Expected Benefit

The results from this research study would benefit Airbus SE and other companies to understand the risks that the regulations and other pressures around PFAS has on the market and to position the company according to the opportunities and recommendations suggested. In addition, this study will be of service to readers who are not aware of these toxic ‘forever chemicals’ which are commonly found in products that people drink, eat, and use on daily basis without knowing that they are silent threats.

CHAPTER II
LITERATURE REVIEW

PFAS are a group of man-made chemicals that have been in use since the 1930s, but their environmental impact was not fully understood until the 1980s. They have been found to be pervasive pollutants that can affect aquatic ecosystems worldwide (Jarvis, Justice, Elias, Schnitker, & Gallagher, 2021; Sun, et al., 2016). The adverse health effects of PFAS have raised public awareness, leading to a voluntary phase-out plan of the two most common PFAS, PFOS and PFOA, in 2009 (U.S. Environmental Protection Agency (EPA), 2017). This phase-out plan has led to the development of shorter-chain PFAS, which do not bioaccumulate and are potentially less toxic. One example of a short-chain PFAS is hexafluoropropylene oxide dimer (HFPO-DA), also known as GenX, which has been used by Dupont since 2010 as a replacement for PFOA in the production of Teflon (Sun, et al., 2016; U.S. Environmental Protection Agency (EPA), 2021). The use of shorter-chain PFAS is seen as a step towards reducing the environmental and health risks associated with PFAS. However, the potential toxicity and environmental persistence of these compounds are still a subject of ongoing research and regulatory scrutiny. In this study, there are two main parts of the literature review to examine and discuss the impacts from PFAS regulatory pressure on key application within Airbus SE supply chain as follows:

2.1 Per- and polyfluoroalkylated substances (PFASs) and its toxicity

Persistent organic pollutants (POPs) and other hydrophobic contaminants tend to accumulate in lipid-rich tissues such as adipose tissue in biota. Among the most pervasive of these, perfluoroalkyl substances (PFASs) are proteinophilic and have a high affinity for binding to proteins in the blood, liver, and kidney tissues. (de Solla, de Silva, & Letcher, 2012; Labadie & Chevreuill, 2011; Butt, Berger, Bossi, & Tomy, 2010)

PFASs, including perfluorooctane sulfonic acid (PFOS), were first discovered in wildlife and human blood plasma in the early 2000s (Hansen, Clemen, Ellefson, & Johnson, 2001; Buck, et al., 2011), and since then, numerous studies have confirmed their widespread occurrence in blood plasma from populations worldwide (Eriksen, et al., 2013; Midasch, Schettegen, & Angerer, 2006; Halldorsson, et al., 2012; Maisonet, et al., 2012; Hansen, Clemen, Ellefson, & Johnson, 2001).PFASs have been shown to bioaccumulate and biomagnify in food chains, with concentrations increasing as they move up the food chain. This is due to their persistence and long half-lives, as well as their ability to accumulate in the tissues of living organisms. Studies have shown that PFAS concentrations in top predators such as polar bears, whales, and seals can be much higher than in organisms lower down in the food chain (Sonne, 2010; Giesy & Kannan, 2001; Butt, Berger, Bossi, & Tomy, 2010). Additionally, there is evidence that PFAS concentrations in water-living organisms are correlated with their distance from point sources of contamination. (de Solla, de Silva, & Letcher, 2012)

The toxic effects of PFASs on the liver, endocrine system, and immune system have been demonstrated in animal studies, with some studies also indicating a link between PFAS exposure and neonatal death and tumor development (Halldorsson, et al., 2012; Stahl, Mattern, & Brunn, 2011; Steenland, Fletcher, & Savitz, 2010). While more research is needed to fully understand the health effects of PFAS exposure on humans, there is growing concern about the potential impacts on human health, particularly for vulnerable populations such as infants and pregnant women. Food and beverages are the primary exposure pathways for PFASs to humans, either directly through contaminated food sources or indirectly through the use of food packaging materials that contain PFASs (Skutlarek, Exner, & Färber, 2006; Felizeter, McLachlan, & de Voogt, 2012). Dust and air can also contribute to important human exposure, as PFASs can be released into the environment through various industrial and consumer products (Felizeter, McLachlan, & de Voogt, 2012; Stahl, Mattern, & Brunn, 2011; Haug, Huber, Becher, & Thomsen, 2011).

Studies have detected various PFASs in human sera, breast milk of pregnant women, and in newborns, indicating that PFASs can be transferred from mother to fetus during pregnancy and through breast milk after birth. PFASs can cross the placenta and accumulate in fetal tissues, potentially affecting fetal development and health

(Maisonet, et al., 2012; Halldorsson, et al., 2012; Stahl, Mattern, & Brunn, 2011). In addition, PFASs have been detected in human blood, with some studies indicating that certain populations may have higher exposure levels due to their occupation or geographic location.

Health effects of PFAS exposure in humans are still being studied and not yet fully established. However, there is evidence to suggest that exposure to PFASs may have negative health impacts.

Studies have found that higher PFAS concentrations in the blood serum of pregnant women may be associated with lower birth weights in their newborns, as well as with increased risk of preterm birth and miscarriage. Similar associations have been observed for other PFASs, such as PFOA and PFHxS (Maisonet, et al., 2012). In addition, there is some evidence to suggest that exposure to PFASs may have long-term health effects. For example, a positive correlation has been observed between PFOA concentrations in the blood serum of pregnant women and higher BMI, waist circumference, and serum insulin and leptin levels in their female offspring at 20 years of age (Halldorsson, et al., 2012). Other studies have suggested a possible link between PFAS exposure and increased risk of thyroid disease (Melzer, Rice, Depledge, Henley, & Galloway, 2010).

2.2 Enterprise Risk Management (ERM)

Enterprise Risk Management (ERM) is a comprehensive approach to managing risks across all aspects of an organization. It has gained significant attention in both academic and practitioner circles due to its potential to improve organizational performance, enhance decision-making, and reduce risk-related costs. In this literature review, I will provide an overview of the key concepts and findings related to ERM and a risk map which is an important tool for ERM.

The concept of ERM was first introduced in the late 1990s and early 2000s (The “Next Frontier” of Enterprise Risk Management – From Compliance to Strategy, 2016), primarily in response to a series of high-profile corporate scandals and financial crises (Dickinson, 2001). ERM represents a departure from traditional, siloed approaches to risk management and emphasizes the need for a more integrated, holistic

approach that considers risks across the entire organization. This departure is a key characteristic of ERM and is reflected in the definition and guiding principles put forth by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) in their 2004 ERM Integrated Framework. In this framework, COSO defines ERM as "a process, effected by an entity's board of directors, management, and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives (PricewaterhouseCoopers LLP and Committee of Sponsoring Organizations of the Treadway Commission, 2004)."

Several studies have explored the impact of ERM on organizational performance. For example, a study by Beasley et al. found that firms with a higher level of ERM implementation had lower variability in their stock returns and were less likely to experience negative earnings surprises (Beasley, Clune, & Hermanson, 2005). In summary, ERM is an essential tool for managing risks in today's complex business environment. By implementing ERM, organizations can better identify and manage risks, minimize losses, and improve overall performance.

To identify, assess, and prioritize risks based on their likelihood and impact, a risk heat map is a visual tool used in Enterprise Risk Management (ERM). It is an important element of ERM as it allows organizations to identify and prioritize risks based on their likelihood and potential impact. In this literature review, I will provide an overview of the key concepts and findings related to risk heat maps in ERM.

Several studies have explored the use of risk heat maps in ERM. For example, a study by Deloitte found that a risk heat map was the most commonly used risk visualization tool, with 75% of respondents reporting its use. The study also found that organizations that used a risk heat map were more likely to have a mature ERM program and were better equipped to respond to risks (Deloitte, 2016).

Another article by Dallu found that the use of a risk heat map was an effective way to communicate risk within the organization. The article found that risk heat maps enabled senior management save time to better understand the organization's risks and make more informed decisions (Dallu, 2020).

The use of risk heat maps is also analyzed. An article by Schmoeller found that risk heat maps were a useful tool for communicating risk information and promoting risk awareness among stakeholders (Schmoeller, 2022). However, another study by Monat and Doremus also identified some limitations of risk heat maps, including the potential for subjective interpretation, lack of consideration of psychological factors important in decision-making, all of which can yield the significant tendency for risk mis-prioritization. (Monat & Doremus, 2018)

In conclusion, a risk heat map is an important element of ERM that can help organizations to better understand and manage their risks. According to several studies mentioned, it is found that risk heat maps are effective in communicating risk information to senior management and promoting risk awareness among staff and stakeholders.

CHAPTER III
RESEARCH METHODOLOGY

This chapter describes the approach and procedures used for conducting the study, which includes five main steps: defining the problem, developing a framework, collecting data, creating research tools, and analyzing the data. Each step is crucial in ensuring the accuracy and validity of the research results.

3.1 Research Design

The Toulouse School of Management (TSM) has formed a multicultural group consisting of four members from different cultural backgrounds, as shown in Figure 3.1. From left to right, the team members are Miss Chloé TROUILLOT, Miss Victoria KEMPF, and Mr. Jean PRUVOT, who are all French, and Miss Chanaradee RODJANAPISIT, who is Thai. The team's diversity is expected to bring a range of perspectives, experiences, and knowledge that can be beneficial in achieving the research's objectives. Before the kick-off meeting with Airbus SE, the team met to discuss sustainability concepts as part of the UE9 International Project Management & Consulting Projects course. This consulting project took two months to complete in Toulouse, France. To monitor progress, biweekly meetings were held between the team and the company, culminating in a final oral presentation and submission of the final report.

Figure 3.1 The photograph of the team taken at Airbus SE

3.1.1 Problem Definition

The company provided the team with a research topic and problem details related to the regulatory pressure on PFAS in key applications within Airbus SE supply chain. Airbus SE has identified four main supply sectors of interest: lubricants, metal plating, electronics, and firefighting foam. The academic tutor, Mr. Dang-Huy Cao, briefed the team on the problems and provided guidelines on how to proceed with the research. The company wants to understand the impact of PFAS regulations and other pressures on its market position to minimize sustainability impacts related to its supply chain for key applications. The research will assess potential risks and impacts of PFAS regulatory pressure on Airbus SE supply chain and provide recommendations on how the company can position itself to minimize environmental effects and supply chain risks associated with PFAS regulations.

3.1.2 Framework Development

Despite the widespread use of PFAS-containing products in various areas of Airbus SE supply chain, including cleaners, extinguishers, tapes, synthetic fiber production, electronic coatings or semiconductors production, metal plating, surface

treatments, lubricants, corrosion inhibitors, metal finishing, organic chemical production, polymer production, textiles, personal protective equipment, among others, Airbus SE has decided to concentrate its efforts on specific PFAS applications. These include metal plating, electronics, and firefighting foam. This decision was made after thorough reviews and discussions.

The team has developed a conceptual framework that will guide the entire research study. This framework serves as a visual representation of the key relationships that the study will explore. By using this framework, the team aims to provide a structured approach to data analysis and interpretation, which will ultimately lead to a deeper understanding of the research problem.

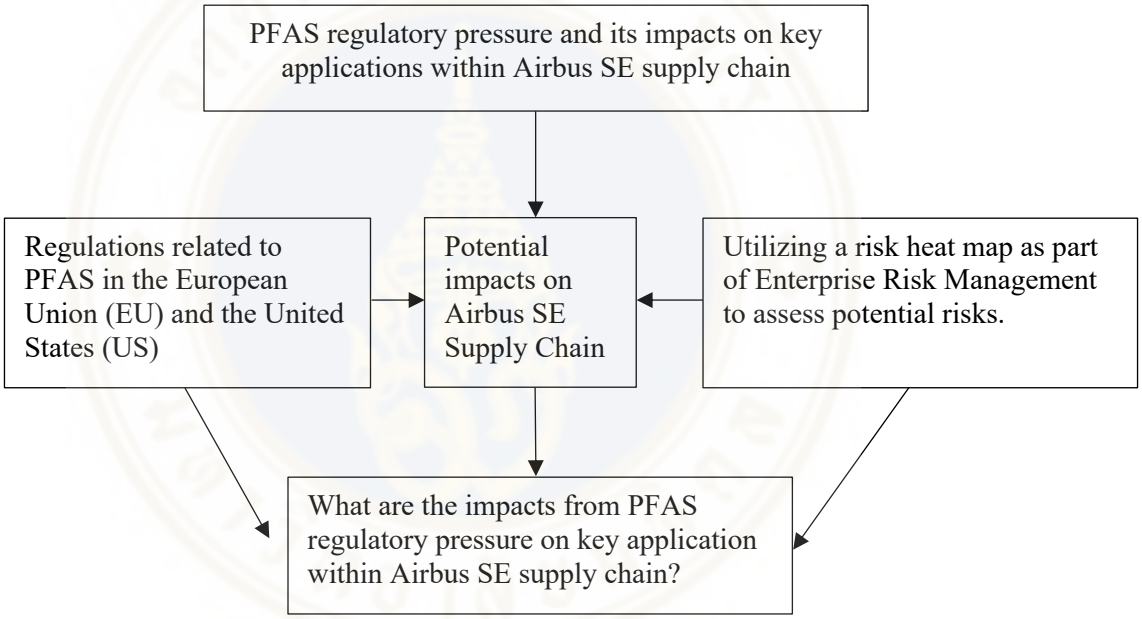

Figure 3.2 Research Framework

3.1.3 Data Collection

The team relied mostly on secondary sources, such as internet and online articles, to gather information on PFAS regulations and their health effects. We also participated in online conferences such as Webinar: Launch of the PFAS Guide and from International Chemical Secretariat (Chemsec) which is an independent non-profit organization that advocates for substitution of toxic chemicals to safer alternatives. Furthermore, the team also contacted Aviva Investors who are “a group of 47 investors to the 54 largest chemical producers, calling for increased transparency, phase-out of

persistent chemicals, and improved chemicals management" to gain their aspects and concerns about a potentially stricter regulatory environment for hazardous which will guide the team on how to recommend Airbus SE to position itself in the situation. They kindly gave the team a letter which they sent to chemical producers (See Appendix). Lastly, the team also attempted to contact the main suppliers in each sector of key applications within Airbus SE supply chain to inquire about the amount of PFAS in their products, but they were not willing to share such information, and the team did not visit any suppliers. The goal of these efforts was to help Airbus SE identify PFAS hotspots in their business and minimize the environmental effects and supply chain risk from the impacts of PFAS regulations.

3.1.4 Analysis

The team had to rely on online information to analyze potential impacts on Airbus SE supply chain because the company did not disclose any supplier lists to outsiders, as they considered this information private. The team selected a target group of suppliers based on publicly available financial performance information, which may or may not have included the exact suppliers that Airbus SE worked with. Additionally, these suppliers were unwilling to reveal any details about their products that may or may not contain PFAS. Therefore, the team had to work with limited information and assumptions when analyzing the potential impacts of PFAS regulations on Airbus SE supply chain.

Based on the limited information available, the team decided to focus on two factors for selecting suppliers for the research: the number of employees working in the supplier company and the financial performance of the supplier company. Using these criteria, the team identified two supplier companies for each of the key application sectors as the target group for the research.

To assess the potential risks associated with these suppliers, the team created a risk heat map. This tool is commonly used to visually represent the likelihood and impact of different risks associated with the use of PFAS in Airbus SE's products. By identifying the risks with the highest likelihood and impact, the team was able to prioritize the risks that Airbus SE should focus on to minimize environmental effects and supply chain risk from the impacts of PFAS regulations.

CHAPTER IV
RESEARCH FINDINGS AND DATA ANALYSIS

In this chapter, the study presents the outcomes of the group brainstorming sessions which include:

1. Key regulations related to PFAS in the European Union (EU) and the United States (US).
2. Assessing the impacts of PFAS regulations on Airbus SE supply chain.

4.1 Key regulations related to PFAS in the European Union (EU) and the United States (US)

4.1.1 Key PFAS regulations in the EU and their years of adoption

In the EU, the regulation of PFASs has been primarily led by the European Chemicals Agency (ECHA) and the European Food Safety Authority (EFSA).

- In 2009, perfluorooctanoic acid (PFOA), its salts, and Perfluorooctane sulfonates (PFOS) and its salts were added to Annex XVII of REACH regulation, which prohibits their manufacture, use, and marketing in concentrations equal to or greater than 0,1 % by weight calculated with reference to the mass of structurally or microstructurally distinct parts in a wide range of consumer and professional products (European Chemicals Agency, 2009).
- In 2018, EFSA published a Scientific Opinion on the risks to public health related to the presence of PFASs in food. The Opinion identified a need for further data on PFASs in food and recommended that dietary exposure to PFASs should be reduced as much as possible (European Food Safety Authority (EFSA), 2018).

- In 2022, the European Commission published a PFAS Action Plan, which outlines a range of measures to address PFAS contamination in the EU. The Action Plan includes proposals for new regulations, research initiatives, and collaboration with international partners (European Commission, 2022).
- In 2023, ECHA submitted a PFAS restriction proposal to restrict the manufacture, use, and placing on the market of PFASs, including their salts and related substances, with certain exemptions for critical uses. The proposed restriction covers a wide range of products and industries (European Chemicals Agency (ECHA), 2023).

These regulations demonstrate a growing awareness and concern about the risks posed by PFASs in Europe, and a recognition of the need to take action to regulate these substances. It is likely that additional regulations will be established in the future as more information becomes available about the environmental and health impacts of PFASs.

4.1.2 Key PFAS regulations in the US and their years of adoption

In the US, PFAS regulations are primarily established at the state and provincial levels, although there have been some federal regulations as well.

- In 2019, the state of Maine became the first state in the US to ban the use of PFAS in food packaging (State of Maine, 2019), while Washington and New York followed in 2020 with similar laws (State of Washington, 2020; State of New York, 2020).
- In 2022, the US Environmental Protection Agency (EPA) issued PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024, setting a combined lifetime exposure limit of 70 parts per trillion (ppt) (U.S. Environmental Protection Agency (EPA), 2022). This advisory is not enforceable by law, but it provides guidance for water utilities and states in setting their own regulatory limits.
- In 2023, the US Environmental Protection Agency (EPA) issued the first national drinking water standard for six per- and polyfluoroalkyl substances under President Biden's plan to combat PFAS pollution and Administrator Regan's PFAS Strategic Roadmap (U.S. Environmental Protection Agency

(EPA), 2023). The proposal regulates two chemicals, PFOA and PFOS, at 4 parts per trillion (ppt). For PFNA, PFHxS, PFBS and GenX chemicals, the EPA proposes not only one standard for each but also a limit for a mix of them. (Christensen, 2023).

These regulations demonstrate a growing awareness and concern about the risks posed by PFAS in the US, and a willingness to take action to minimize exposure to these substances in drinking water and other environmental media.

4.2 Assessing the Impacts of PFAS Regulations on Airbus SE Supply Chain

4.2.1 Risk Assessment of PFAS products and services in Airbus SE Supply Chain

4.2.1.1 Lubricants

Firstly, Airbus SE considers lubricants, such as grease, as an essential element in its supply chain. The team selected two companies for the lubricants section that are deeply connected to the aerospace and automotive industries. These companies have a specific focus on creating premium products, boast a substantial workforce, and demonstrate impressive financial results.

- ExxonMobil is a major player in the lubricants industry, manufacturing top-notch lubricants for a range of purposes. They provide an extensive selection of lubricants, including synthetic lubricants, marine lubricants, automotive lubricants, and industrial lubricants. ExxonMobil's lubricant products are recognized for their exceptional performance and dependability, which has made them a reliable choice for customers worldwide. In 2023, Exxon Mobil has 72,000 employees (Zippia, Inc., 2023) and its full-year 2022 earnings were $55.7 billion compared with $23.0 billion in 2021, an increase of $32.7 billion (ExxonMobil, 2023)
- Royal Dutch Shell is also a leader in the lubricants industry, providing lubricants for a range of industries, such as automotive, marine, aviation, and industrial

applications. Shell's lubricants are widely recognized for their exceptional performance and reliability, as well as their capacity to reduce maintenance expenses and improve efficiency. Customers select Shell for its excellent products and dedication to sustainability. Shell employed approximately 93,000 people worldwide in 2022 (Aizarani, statista, 2023) and its earnings results for the fourth quarter ended December 31, 2022. For the fourth quarter, the company reported sales was $101,303 million compared to $85,280 million a year ago. Revenue was $101,195 million compared to $90,223 million a year ago (Fusion Media Limited, 2023).

To sum up, the lubricant industry is highly varied and competitive, with customers having a multitude of options to select from. The primary considerations that influence customer preference are quality, reliability, cost-effectiveness, and sustainability.

The lubricant industry is facing new challenges due to the implementation and ban of PFAS regulations. Lubricant manufacturers are under pressure to find alternative products that meet evolving regulatory requirements, which is a significant challenge. Despite this, the industry is constantly evolving, with companies developing innovative products that meet the changing needs of customers while also reducing environmental impact. PFAS and PTFE, although not commonly used in aerospace lubricants or grease, are prevalent in other industries such as automotive. However, it's possible that some lubricants or greases could contain trace amounts of PFAS or PTFE as impurities, contaminants, or processing aids.

Analyzing the impact of regulations related to PFAS in the lubricant market, the team will use a portfolio analysis presented in table 4.1 to assess the transparency of companies in disclosing their use of PFAS in their lubricants and identify their willingness to share the portion where PFAS-containing products are used.

Table 4.1 Portfolio analysis on ExxonMobil and Royal Dutch Shell

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Shell	Turbofan Engine Oil	AeroShell Turbine Engine Oil 560	Suspected user of PFAS	No
Shell	Turbine engine oil	AeroShell Ascender	Suspected user of PFAS	No
Shell	Multi-purpose airframe grease	AeroShell Grease 33	Suspected user of PFAS	No
Shell	Turbine engine oil	AeroShell Turbine Engine Oil 390	Suspected user of PFAS	No
Shell	Wheel bearing grease	AeroShell Grease 22	Suspected user of PFAS	No
ExxonMobil	Hydraulic Fluid	Mobil Aero HF	Suspected user of PFAS	No
ExxonMobil	Hydraulic Fluid	Mobil HyJet V	Suspected user of PFAS	No
ExxonMobil	Hydraulic Fluid	Mobil HyJet IV-A plus	Suspected user of PFAS	No
ExxonMobil	Aviation Grease	Mobil™ Aviation Grease SHC™ 100	Suspected user of PFAS	No

Table 4.1 Portfolio analysis on ExxonMobil and Royal Dutch Shell (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
ExxonMobil	Aviation Grease	Mobilgrease™ 33	Suspected user of PFAS	No
ExxonMobil	Aviation Grease	Mobilgrease™ 28	Suspected user of PFAS	No

Based on the findings presented in Figure 4.2, ExxonMobil and Royal Dutch Shell have a high likelihood of risk according to a risk heat map assessment, with a range of 60-75%. This is likely due to suspicions that products from both companies contain PFAS, and the companies have been unwilling to share the portion where PFAS-containing products are used. The lack of transparency regarding the use of PFAS in their products can lead to increased scrutiny and potential legal and reputational risks for these companies. If Airbus SE continues to work with these companies as its top suppliers for lubricants, it could face legal and reputational risks. For example, if there were to be a regulatory crackdown on the use of PFAS in lubricants, Airbus SE could be implicated for not taking sufficient measures to address the issue in its supply chain. Additionally, the company's reputation could suffer if it is seen as not taking the necessary steps to address environmental and health risks associated with PFAS usage.

Moreover, as more consumers become aware of the environmental and health risks of PFAS, they may choose to avoid products that contain these chemicals. This could lead to a decrease in demand for Airbus SE products.

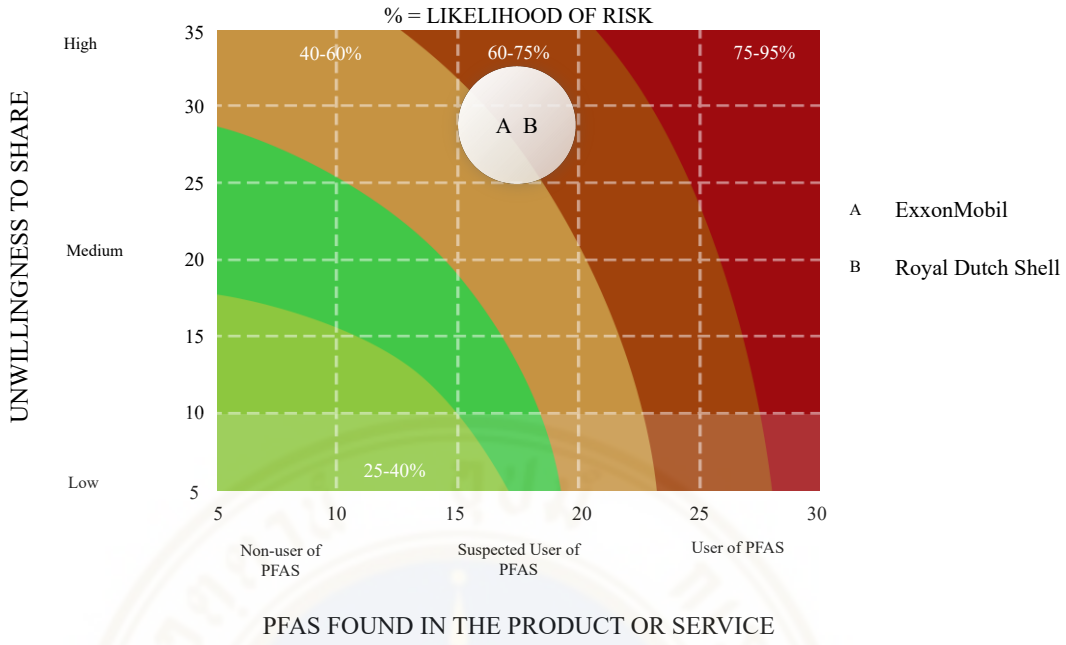

Figure 4.2 A risk heat map assessment on ExxonMobil and Royal Dutch Shell

4.2.1.2 Metal Plating

Secondly, one of Airbus SE supply chain is metal plating products. Airbus SE application areas of metal plating are abrasion and wear resistant coatings, anti-slip paint and sealing. Many companies involved in metal plating are suspected to use PFAS, according to the Environmental Working Group (EWG) (Environmental Working Group (EWG), 2020). PFAS are utilized as coatings on metal surfaces to protect them from weathering, staining, corrosion, and to enhance solar reflectivity. The application of these coatings typically occurs during the fabrication of the metal. Two common types of PFAS used in metal plating are PVDE and PTFE. The team has identified two plating suppliers. These companies have a particular focus on creating superior quality products and have a significant workforce, along with exhibiting impressive financial performance.

- In Perfection Plating, Inc. is a supplier that specializes in metal plating services. They offer rackplating, coil and barrel, and reel to reel services, and are compliant with the Reduction of Hazardous Substances (RoHS) regulations. They provide various finishes such as copper, nickel-phosphorus, nickel, tin, palladium-nickel, palladium, silver, and gold. The company has 100-199 employees and generates annual sales in the range of $50-99.9 million. (THOMAS, 2023)
- Techmetals, Inc. is a well-known company in the metal plating industry, certified by the International Organization for Standardization (ISO) and the National Aerospace and Defense Contractors Accreditation Program (NADCAP). The company provides plating services, including cadmium, hard chrome, copper, nickel, tin, zinc, and zinc-nickel plating, to various industries such as aerospace, space, automotive, medical, agricultural, heavy equipment, food processing, defense, and more. Techmetals, Inc. has a workforce of 200-499 employees and annual sales of $25-49.9 million. (THOMAS, 2023).

After conducting research into the featured metal plating companies, the team discovered that all of them are suspected users of PFAS. The Environmental Protection Agency (EPA) has determined that metal finishing and electroplating facilities use PFAS to control dangerous chromium emissions, which are known human carcinogens and inhalation hazards. The EPA has identified industrial facilities that

perform certain chromium operations such as chromate conversion coating operations, chromic acid etching, chromium anodizing, and chromium plating as the primary sources of PFAS discharges in wastewater from chrome finishing activities. Therefore, the EPA has announced its plan to survey the finishing and coating industry to review and revise, as appropriate, effluent limitations guidelines and standards (ELGs) for point source categories. The survey, called "Information Collection Request for the Metal Finishing and Electroplating Industry," contains 84 questions divided into nine specific sections, which cover general facility information, facility operations and PFAS use, wastewater generation, flow diagram, management and treatment, permit requirements, environmental and other information, financial information, and comments (Pennington, 2022).

Based on the EPA's announcement, it seems that PFAS discharges from metal finishing and electroplating facilities are a significant concern for the agency. The team will use a portfolio analysis in table 4.3 to evaluate metal plating service providers' transparency in disclosing their use of PFAS and their willingness to share information about the amount of products containing PFAS. The purpose of this analysis is to understand how regulations related to PFAS affect the metal plating industry.

Table 4.3 Portfolio analysis on Perfection Plating, Inc. and Techmetals, Inc.

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Perfection Plating, Inc.	Providing electroplating services in electronic, automotive, communication, aerospace, and	Reel to reel plating, loose piece barrel and rack plating, coil plating.	Suspected user of PFAS (U.S. Environmental Protection Agency (EPA), n.d.)	No

Table 4.3 Portfolio analysis on Perfection Plating, Inc. and Techmetals, Inc. (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
	medical industries (Perfection Plating, Inc., 2023)	(Perfection Plating, Inc., 2023)		
Techmetals, Inc.	Providing metal plating and coating industry – proudly assisting players in the Aerospace, Military, Manufacturing, Automotive and Medical fields (Techmetals, Inc., 2023)	Cadmium plating, zinc-nickel plating, electroless nickel (EN) plating, silver plating, copper plating (Techmetals, Inc., 2023)	Suspected user of PFAS (U.S. Environmental Protection Agency (EPA), n.d.)	No

According to the risk heat map assessment presented in Figure 4.4, Perfection Plating, Inc. and Techmetals, Inc. are at a high risk with a likelihood range of 60-75%. The reason for this could be the suspicion that their products contain PFAS and the lack of disclosure regarding the unwillingness to share information. This lack of

transparency could result in increased scrutiny and possible legal and reputational risks for these companies.

It is possible that Airbus SE may face legal and reputational risks if it continues to work with Perfection Plating, Inc. and Techmetals, Inc. as their top suppliers for metal plating. This is because these companies have been identified as having a high likelihood of using PFAS in their metal plating processes, based on the risk heat map assessment presented in Figure 4.4.

If Airbus SE continues to work with these suppliers without proper due diligence and transparency, it could face legal risks if it is found that its products contain PFAS above the legal limits. Additionally, there could be reputational risks if the public becomes aware of the company's association with suppliers that use PFAS, which are increasingly being recognized as harmful to human health and the environment.

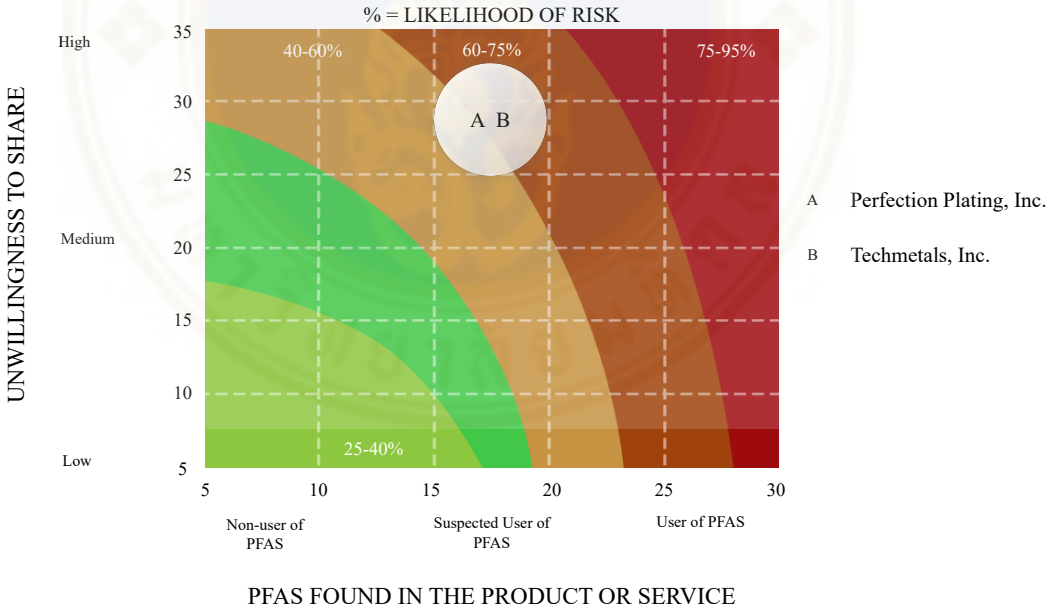

Figure 4.4 A risk heat map assessment on Perfection Plating, Inc. and Techmetals, Inc.

4.2.1.3 Electronics

Thirdly, Airbus SE relies on electronics products within its supply chain as a key component. Airbus SE application areas of electronics are cables, connectors, sleeves, and insulation. In order to enhance the quality and functionality of electronic products, manufacturers have utilized PFAS for their distinctive characteristics. The semiconductor sector is particularly reliant on these substances, but they can also be found in other products including wires, cables, printed circuit boards, high-temperature film capacitors, and liquid crystal displays (Chemical Watch, 2020).

According to IPC, the global electronic industry association, PTFE, and other fluoropolymers are commonly used to provide insulation for wires and cables in various electrical and electronic applications. These types of cables are particularly useful in harsh environments and situations requiring high-volume data transmission, such as in automotive electronics, medical equipment, and data centers. In addition to their use in cables, fluoropolymers are also used as a fiber-reinforced layer in printed circuit boards (PCBs) and other electronic products (Scanlon, 2020). The team underlined two electrical cable manufacturers that are of interest with a focus on producing top-notch products and have a considerable workforce with a robust financial performance.

- W. L. Gore & Associates, Inc. is skilled in manufacturing electrical cables and cable assemblies for use in different industries, such as telecommunications, aerospace, and defense. Gore discovered Expanded polytetrafluoroethylene (ePTFE) which is a material central to diverse products include cables (W. L. Gore & Associates, Inc., 2019). The cables produced by Gore are of high quality and offer fast data transfer, reliable signal integrity, and durability even in harsh conditions. The company provides a range of cables, including high-speed data cables, microwave/RF assemblies, power cables, and aircraft cables. Gore cables are also known for their exceptional shielding effectiveness, low attenuation, and resistance to corrosive materials, abrasion, and freezing temperatures (Rayming Technology, 2021). Gore has a workforce of 10,500 people (Zippia, Inc., 2023). Gore's peak revenues was $3.2 billion in 2022 (Zippia, Inc., 2023).

- Corning Inc. is a company that specializes in producing and selling glasses, ceramics, and related materials. Its products include glass substrates for various electronics such as TVs, monitors, and laptops, as well as hardware, cables, and tools for telecommunications networks, automotive filters, ceramic substrates, and labware for scientific research. Additionally, Corning produces specialized glassware and optics for industries such as consumer electronics, aerospace and defense, and telecommunications. The company headquarter was located in New York (Rayming Technology, 2021). Corning has a global workforce of approximately 61,200 employees and generated $14.08 billion in revenue in the year 2021 (U.S. Securities and Exchange Commission (EPA), 2022).

Based on IPC's study, fluoropolymers, including PTFE, which is a type of PFAS, are commonly employed to insulate cables in diverse electrical and electronic applications due to its excellent electrical insulation, high thermal stability, and chemical resistance. To assess the transparency of electrical cable manufacturers in terms of disclosing their use of PFAS and their willingness to share information about the presence of PFAS in their products, the team plans to utilize a portfolio analysis table 4.5.

Table 4.5 Portfolio analysis on W. L. Gore & Associates, Inc., and Corning Inc.

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Gore	Aerospace electrical cable for civil aircraft	GORE® Microwave/RF Assemblies, 7 Series for Civil Aircraft	User of PFAS (Penton Media, Inc., 2009)	Yes (Penton Media, Inc., 2009)

Table 4.5 Portfolio analysis on W. L. Gore & Associates, Inc., and Corning Inc. (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Gore	Aerospace electrical cable for civil aircraft	GORE® Abrasion Resistant Cable Jacket for Civil Aircraft	User of PFAS (Penton Media, Inc., 2009)	Yes (Penton Media, Inc., 2009)
Gore	Aerospace electrical cable for civil aircraft	GORE® Ethernet Cables for Civil Aircraft	User of PFAS (Penton Media, Inc., 2009)	Yes (Penton Media, Inc., 2009)
Gore	Aerospace electrical cable for civil aircraft	GORE® Ethernet Cables for Civil Aircraft	User of PFAS (Penton Media, Inc., 2009)	Yes (Penton Media, Inc., 2009)
Gore	Aerospace electrical cable for civil aircraft	GORE® Quad Cables (Specialty Versions) for Civil Aircraft	User of PFAS (Penton Media, Inc., 2009)	Yes (Penton Media, Inc., 2009)

Table 4.5 Portfolio analysis on W. L. Gore & Associates, Inc., and Corning Inc. (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Corning	Outdoor Aerial Cables	ALTOS® Loose Tube, Gel-Free, All-Dielectric Cable with FastAccess® Technology	User of PFAS (Corning Inc., 2023)	Yes (Corning Inc., 2023)
Corning	Outdoor Aerial Cables	ALTOS® Loose Tube, Gel-Free, All-Dielectric Cables with Binderless FastAccess® Technology	User of PFAS (Corning Inc., 2023)	Yes (Corning Inc., 2023)
Corning	Outdoor Aerial Cables	ALTOS® Loose Tube, Gel-Free Cable	User of PFAS (Corning Inc., 2023)	Yes (Corning Inc., 2023)
Corning	Outdoor Aerial Cables	ALTOS® Figure-8 Loose Tube, Gel-Free Cable	User of PFAS (Corning Inc., 2023)	Yes (Corning Inc., 2023)

Table 4.5 Portfolio analysis on W. L. Gore & Associates, Inc., and Corning Inc. (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Corning	Outdoor Aerial Cables	ALTOS® Loose Tube, Gel-Free, Double-Jacket Cable	User of PFAS (Corning Inc., 2023)	Yes (Corning Inc., 2023)

Figure 4.6, which shows a risk heat map assessment, indicates that W. L. Gore & Associates, Inc. and Corning Inc. are at a high-risk level with a likelihood range of 75-95%. This is likely due to concerns regarding the presence of PFAS in their products and their unwillingness to disclose information about their use. The failure to be transparent about the chemicals used in their products could result in heightened scrutiny and potential legal and reputational risks for these companies. If Airbus SE continues to work with these suppliers for electronics, it could face legal and financial penalties, as well as damage to its reputation as a socially responsible company. Additionally, the negative impact of PFAS contamination on human health and the environment could harm the company's reputation and result in a loss of customer trust. Therefore, it is important for Airbus SE to consider the potential risks associated with its supply chain and work with suppliers to reduce or eliminate the use of PFAS in their products and processes.

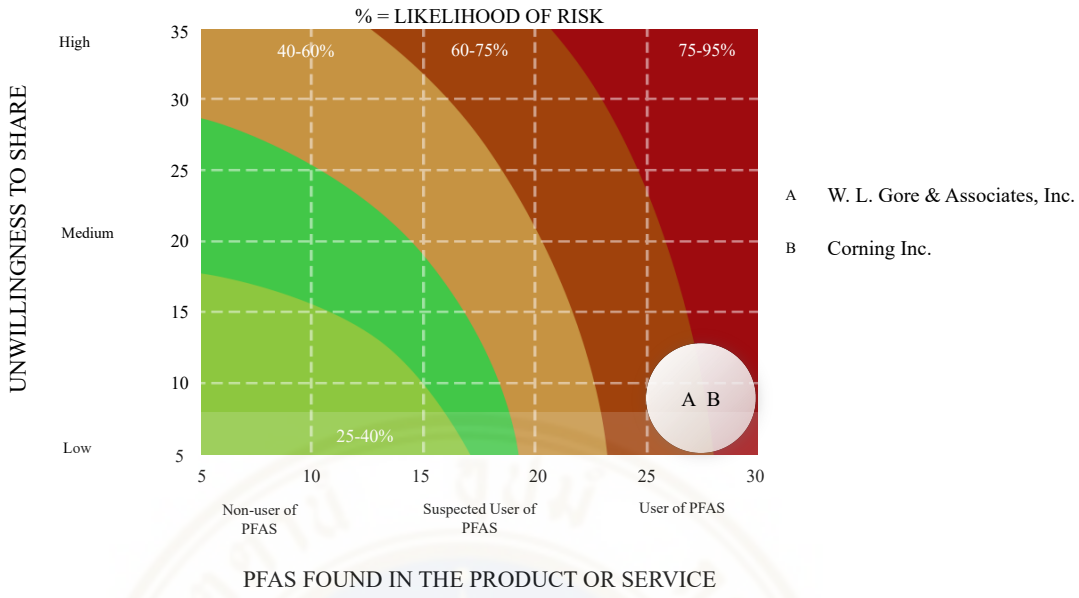

Figure 4.6 A risk heat map assessment on W. L. Gore & Associates, Inc., and Corning Inc.

4.2.1.4 Firefighting foam

Lastly, Airbus SE uses firefighting foams as a crucial element in its supply chain such as cooling agents and fire extinguishers in lavatory, handheld, cargo, engine, and auxiliary power unit (APU) in aircrafts. Aqueous Film-Forming Foam (AFFF) is a type of firefighting foam that contains PFAS and is used to prevent and fight fires involving flammable liquids. It is commonly used in various industries such as military, aviation, chemical plants, and refineries. However, the main concern with AFFF is its persistence in wastewater treatment plants, which can lead to contamination of local water supplies and waterways, as shown in figure 4.7. This poses a potential health hazard to the community. (Wakelin, 2022).

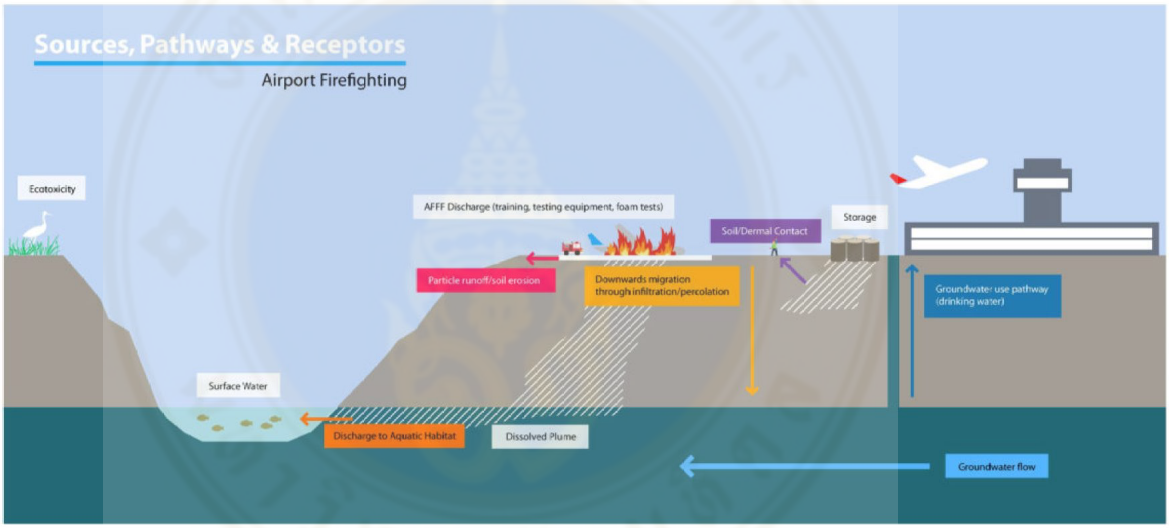

Figure 4.7 The sources, pathways, and receptors of PFAS in AFFF in the airport
Source: Graphic courtesy of the National Science Foundation, 2019

Since 2019, The U.S. Federal Aviation Administration (FAA) has implemented various measures to minimize the discharge of firefighting foam containing PFAS, except in cases of aircraft emergencies (Shepardson, 2021). AFFF containing PFAS has been used for many years in airports worldwide to ensure the safety of passengers, crew, and others. If airports and aircraft manufactures take no action, they may face legal challenges.

The team chose two companies for the firefighting foam section that have significant ties to the aerospace and automotive industries. These companies specialize

in producing high-quality products and have a large number of employees and strong financial performance.

- Perimeter Solutions is a leader in the development and manufacture of firefighting products and fire retardants globally, with operations in the United States and Germany. They offer fire retardants, firefighting foams, and specialized equipment and services for both government and commercial customers. The company was established in 1963 and is based in Missouri (Yahoo, 2023). The company employs 240 people (Macrotrends LLC, 2023). Its net sales for the full year 2022 decreased by 1% from $362.3 million to $360.5 million. Specifically, sales of their firefighting foam products decreased by 13%, from $261.2 million in the previous year to $226.6 million (Perimeter Solutions, 2023).

- Located in Philadelphia, National Foam is a leading manufacturer which provides foam-based solutions to firefighters and fire departments. They create, produce, and promote foam concentrate, foam proportioning systems, fixed and portable foam firefighting equipment, monitors, nozzles, and specialized Big Flow pumping solutions. Additionally, the company provides foam testing, red alert, training, and field services (Craft.co, 2023). National Foam has a workforce of 350 employees and generates a revenue of $18.0 million in 2022 (Zippia, Inc., 2023).

To evaluate the degree to which firefighting foam manufacturers are transparent with regards to disclosing their use of PFAS and their willingness to share information about PFAS in their products, the team intends to use a portfolio analysis table 4.8.

Table 4.8 Portfolio analysis on Perimeter Solutions and National Foam

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
Perimeter Solutions	foam concentrates and gel products	PHOS-CHEK® 1% AFFF	User of PFAS (Perimeter Solutions, 2023)	Yes (Perimeter Solutions, 2023)
Perimeter Solutions	firefighting foam concentrates	PHOS-CHEK® 3% AFFF MIL-SPEC	User of PFAS (Perimeter Solutions, 2023)	Yes (Perimeter Solutions, 2023)
Perimeter Solutions	firefighting foam concentrates	PHOS-CHEK® 1% AFFF Freeze Protected	User of PFAS (Perimeter Solutions, 2023)	Yes (Perimeter Solutions, 2023)
Perimeter Solutions	extinguishing agents and retardants	SOLBERG® ARCTIC 1% SP AFFF	User of PFAS (Perimeter Solutions, 2023)	Yes (Perimeter Solutions, 2023)
National Foam	Foam concentrates	Aer-O-Lite® 3% Cold Foam	User of PFAS (Prominent Media Ltd., 2015)	Yes (Prominent Media Ltd., 2015)

Table 4.8 Portfolio analysis on Perimeter Solutions and National Foam (cont.)

Company	Field or category	Product or service name	PFAS found in the product or service	Willingness to share
National Foam	Foam concentrates	Aer-O-Water® 3EM	User of PFAS. (Prominent Media Ltd., 2015)	Yes (Prominent Media Ltd., 2015)
National Foam	Foam concentrates	Centurion ™ 3%	User of PFAS (Prominent Media Ltd., 2015)	Yes (Prominent Media Ltd., 2015)

According to the risk heat map assessment in Figure 4.9, Perimeter Solutions and National Foam are both rated as having a high likelihood of risk, with a range of 75-95%. This is due to the suspicion that their products contain PFAS and their unwillingness to share information about where these products are used. Since Perimeter Solutions and National Foam are the top suppliers for firefighting foam, this raises concerns about the potential presence of PFAS in Airbus SE's firefighting equipment and the environmental and health risks associated with it.

PFAS-containing firefighting foam can contaminate soil and water, posing a threat to human health and wildlife. Moreover, the use of PFAS in firefighting equipment could lead to legal and regulatory issues for Airbus SE, particularly as more governments and organizations around the world restrict or ban the use of PFAS. As such, continuing to work with Perimeter Solutions and National Foam without addressing the concerns regarding PFAS could put Airbus SE at risk of legal and reputational repercussions. It is important for Airbus SE to consider alternative suppliers

or work with Perimeter Solutions and National Foam to transition to safer, non-PFAS firefighting foam.

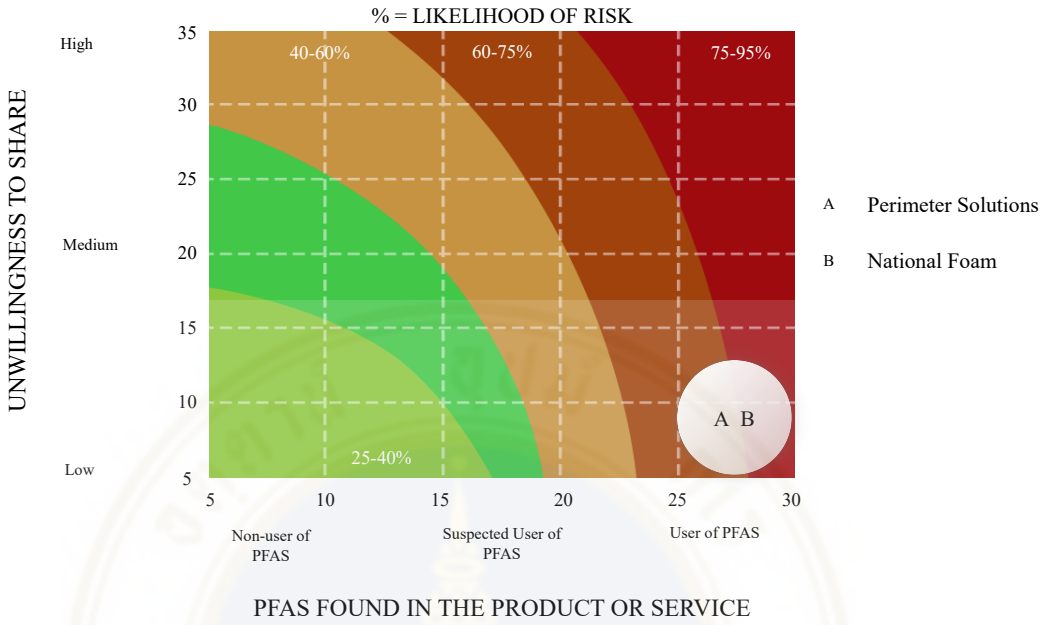

Figure 4.9 A risk heat map assessment on Perimeter Solutions and National Foam

CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the conclusions and recommendations drawn from the study conducted to assess the effects of regulations and other pressures related to PFAS on key applications within Airbus SE supply chain. to offer suggestions to Airbus SE on how to decrease environmental impact and supply chain risks.

5.1 Conclusion

To achieve the consulting internship objectives, the team assess the likelihood of supply chain risk in each key application with a risk heat map as the tool regarding willingness to share and PFAs found in products or services and provide recommendations to Airbus SE.

PFAS has been widely used in a broad range of industrial applications and commercial products due to its resistance ability. Environmentally, PFAS is widely found in public and private water and groundwater throughout the U.S. and the EU. Unfortunately, it is slow and difficult to remove PFAS from environmental media using the technologies traditionally used to remediate environmental conditions. It is also shown that regular exposure to even low concentrations may cause health effects such as testicular, kidney, and prostate cancers. Additionally, corporations including 3M Co., Chemguard Inc., and Dupont are now being sued in more than 6,400 PFAS-related lawsuits in federal courts in the U.S. (Wallender, Companies Face Billions in Damages as PFAS Lawsuits Flood Courts, 2022)

Hence, in response to concerns over the potential consequences of exposure to PFAS on human health, it is recommended Airbus SE should warrant a careful eye over the issues and proceed with strategies for sustainable operations towards impacts to deal with its supply chain risk that relates to PFAS products and services in Airbus

SE supply chain which are lubricants, metal plating, electronics, and firefighting foam as suggested in this study.

5.2 Recommendations

The recommendations given to Airbus SE are categorized into two-time frames, short-term which is within 1-3 years and long-term which is beyond 3 years.

In the short run, Airbus SE should conduct regular audits of its suppliers to ensure compliance with PFAS regulations and to identify any potential risks or areas for improvement. These audits should cover not only the use of PFAS in products and processes, but also the management of PFAS-containing waste and disposal practices. By implementing a responsible sourcing program that requires suppliers to disclose their use of PFAS in their products and processes. This program can also encourage suppliers to transition to alternative, PFAS-free products, and processes.

Additionally, Airbus SE should engage with suppliers and stakeholders. Airbus SE could work closely with its suppliers to ensure that they are aware of any regulatory changes regarding PFAS and that they are taking steps to reduce or eliminate the use of PFAS in their products and processes. Airbus SE should also consider providing guidance and support to suppliers to help them make the transition away from PFAS. Airbus SE could also engage with stakeholders, including customers, investors, and employees, to communicate the company's efforts to address PFAS-related risks in the supply chain. This can help build trust and enhance the company's reputation for responsible business practices. Additionally, this can prevent public relations (PR) crisis in terms of sustainability. Airbus SE could consider publishing regular sustainability reports or conducting stakeholder surveys to gather feedback and demonstrate its commitment to sustainability.

Many companies are investing in research and development for new alternatives of PFAS. Therefore, Airbus SE should also follow this trend in order to prepare for future challenges. In the case that there is no possible or functional alternative, Airbus SE should invest in the infrastructure in order to effectively prevent any release of PFAS into the environment. It will also be necessary to think of setting

up an adequate treatment of waste, without possible impact on the health of the personnel and always without leakage.

On the other hand, in the long run, Airbus SE should collaborate with industry peers. Airbus SE should collaborate with other companies in the aviation industry to share best practices and develop common standards for managing PFAS in the supply chain. This could include joint research and development efforts to identify and develop PFAS-free alternatives. But also engage in industry-wide collaborations to promote the development of alternative, PFAS-free technologies, and products. Airbus SE can leverage its expertise and resources to support research and development efforts in this area. Work with regulatory bodies and industry associations to develop and promote responsible PFAS regulations that balance environmental protection with economic considerations. This can involve advocating for the use of safer alternatives to PFAS and supporting research into the environmental impacts of these alternatives.

In addition, Airbus SE should advocate in the European Commission. Without PFAS, Airbus SE and other aerospace companies would be forced to find alternative solutions that may not be as effective or may be more expensive, potentially increasing costs and reducing competitiveness. As such, Airbus SE and other companies that rely on PFAS have a responsibility to advocate for responsible regulation and management of these substances, rather than an outright ban. This includes supporting research and development of safer alternatives, advocating for more effective regulations and standards to reduce PFAS exposure and emissions, and working with suppliers to promote responsible supply chain management.

Airbus SE can also work with industry associations and government agencies to promote responsible PFAS management practices and ensure that any regulations or bans are based on sound science and risk assessment. This includes engaging in advocating efforts to ensure that the interests of the aerospace industry are taken into account when developing and implementing PFAS regulations. In the end, responsible PFAS management is essential to protect public health and the environment, but it must also take into account the critical role that these substances play in many industrial applications, including those used by Airbus SE. By advocating for responsible regulation and management, Airbus SE can help ensure that these important

applications are protected while also minimizing the impact of PFAS on human health and the environment.

5.3 Limitation of This Study

Several limitations were identified, which are summarized below.

1. Due to privacy and security concerns, Airbus SE could not provide the team with a list of suppliers they work with, only their product application areas, which made it difficult for the team to focus on specific suppliers which specifically related to Airbus SE.

2. A significant number of suppliers were not cooperative in sharing details about their products during the study, despite attempts to gather information through email and phone interviews. This is partly because they are not suppliers for Airbus SE, so they see no obligations to provide any information.

5.4 Future Work

Considering the limitations of this study, it is recommended that further actions be taken in the future.

1. Airbus SE should consider hiring a consulting firm to improve its supply chain management related to PFAS regulations. This should involve providing a more precise list of suppliers that they are currently working with and ensuring that the information provided is accurate. To protect sensitive information, Airbus SE should also require the consulting firm to sign a non-disclosure agreement (NDA). This approach is likely to lead to a more successful outcome and an effective solution to address supply chain risks.

2. If a significant number of suppliers are not willing to provide the necessary information, Airbus SE could provide clear expectations and guidelines to its suppliers regarding the type of information it needs and the importance of compliance with PFAS regulatory requirements. This could help suppliers understand their obligations and encourage them to be more cooperative in providing the necessary information.

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APPENDICES

APPENDIX

16th September 2022

Dear CEO,

We are a group of 47 investors with US $8 trillion under management or advice, writing to you regarding your company's chemical production and disclosure practices, following on from our letter of 9th December 2021. We appreciate the subsequent engagement we have had with companies on this important topic.

Chemical companies have in recent years been involved in a series of lawsuits and litigation, particularly concerning PFAS or persistent chemicals.[1] As the understanding of the problems associated with persistent chemicals is becoming mainstream, legislation is starting to pick up around the world. The EU is implementing its Chemical Strategy for Sustainability, with a key focus on banning persistent chemicals, and in the US, the Environmental Protection Agency recently recommended drastically lowered safety levels for two PFAS in drinking water.[2] This June, UN countries agreed to a global ban on PFHxS, adding it to the Stockholm Convention on persistent organic pollutants.[3]

While some of these regulatory changes only concern a small group of PFAS, we see these developments as the early stages of a potentially stricter regulatory environment for hazardous chemicals in general, in particular for persistent substances.

Therefore, we have the following requests of your company:

1) **Increase transparency**

In the EU and US, companies are obliged to register the production of chemicals. These registers, which are publicly available, can be used by stakeholders to assess the financial risks involved in the production of hazardous chemicals. In other parts of the world however, production is much less transparent. This means greater opacity and uncertainty over the production of hazardous chemicals. As investors, we believe that companies' license to operate is dependent on the public understanding of risks and impacts.

In addition to disclosing the list of hazardous chemicals your company produces, we suggest that you also disclose the *volume* of each of the hazardous chemicals produced. We understand corporate concern over disclosing this information. We saw similar concerns from the apparel and food industry with regard to disclosing information about their supply chain. But their initial skepticism towards publishing the names and addresses of their suppliers has given way to an increasingly high degree of transparency, without adverse consequences. The chemical industry should move in the same strategic direction. We believe it is possible to be more transparent without disclosing confidential information.

We believe that there are several chemical companies that do not produce any additional hazardous chemicals outside the EU or the US. If this is the case, we encourage you to state this publicly.

[1] https://news.bloomberglaw.com/us-law-week/companies-face-billions-in-damages-as-pfas-lawsuits-flood-courts
[2] https://environment.ec.europa.eu/strategy/chemicals-strategy_en; https://www.epa.gov/newsreleases/epa-announces-new-drinking-water-health-advisories-pfas-chemicals-1-billion-bipartisan
[3] https://chemicalwatch.com/502075/un-countries-agree-on-global-pfhxsc2a0ban

2) Publish a time-bound phase-out plan of persistent chemicals from your production

As already noted, we believe that the stricter regulatory environment on both sides of the Atlantic will eventually require chemical companies to phase out most persistent chemicals. We encourage you to lead, not be led, by phasing out and substituting these chemicals. In addition to the financial risks associated with litigation, producers of persistent chemicals face the risk of increased costs associated with reformulating products and modifying processes, which can have significant implications for company performance.

The restriction of hazardous substances will accelerate the transition towards sustainable alternatives, we believe across all markets. For companies that are prepared and innovative, there are opportunities to seize. The producers and users of sustainable alternatives can gain a competitive advantage and be rewarded by capital markets. We also encourage you to educate your customers on the hazards and work with them on alternatives.

3) Work to improve your ranking on ChemScore

ChemScore ranks the world's largest chemical producers based on their efforts to reduce their chemical footprint. It was developed to provide investors with information to assess the chemicals management strategies of the large producers and users. It is managed by ChemSec, an independent Swedish non-profit committed to phasing out the production of hazardous chemicals. The new annual ranking will be published on the 1st of December. To improve your score, you can contact ChemSec and share information, something we as investors encourage you to do.

We would welcome a response to this letter, including an overview of the steps that your company is planning to take to address our requests. Please do also share any recent company developments since our last letter of December 2021 related to these matters.

Yours sincerely,

Eugenie Mathieu, Earth Pillar Lead
Aviva Investors

Victoria Lidén, Sustainability Analyst
Storebrand Asset Management

Co-Signatories

Rogier Krens, CIO Achmea Investment Management
Achmea

Greta Fearman, Senior Responsible Investment Officer
ACTIAM

Marilín Llanes, Chair, Portfolio Advisory Board
Adrian Dominican Sisters

Anders Schelde, Chief Investment Officer
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Two investors have asked for their names not to be made public for reasons of confidentiality.