W. L. Gore & Associates' Comments on Dossier Submitters' Draft EU REACH restriction on PFAS

Public consultation

Request for Derogation: Membranes used for venting of medical devices

July 2023

Gore appreciates the opportunity offered by the public consultation process to provide comments on the Proposal for a Restriction of Per- and polyfluoroalkyl substances (PFAS) (hereinafter **'Restriction Proposal'**).

A 13.5 year derogation for **membranes used for venting of medical devices** is currently proposed for reconsideration in paragraph 5cc. With this statement, Gore will provide information to support a non-time limited derogation.

The conclusions from our statement are summarized as follows:

- Venting applications in non-implantable medical devices would benefit from a more comprehensive analysis in the restriction proposal, which would allow for a better understanding of their critical functionality.
- It would be beneficial to include a discussion on the availability of alternatives for membranes that enable venting (pressure equalisation) in the context of medical devices.
- No alternative is currently available for membranes that enable venting (including after incidental fluid contact) while containing low surface tension liquids, such as bodily fluids, drug mixtures, and chemicals.
- Without a derogation, non-implantable medical devices that vent, filter, and protect must use materials that will not be capable of performing their required functions under all conditions. This would decrease rapid disease diagnosis, effective patient treatments, and patient quality of life.

I. Derogation Request

Considering the arguments and evidence presented below, Gore respectfully requests a non-time limited derogation for membranes used for venting of medical devices (currently under consideration for a 13.5-year derogation in Column 2, paragraph 5.cc of the Restriction Proposal).

II. Brief Description of the End Use

Reliable and consistent operation of non-implantable medical and diagnostic devices is critical to maintain patient comfort, as well as device safety, efficacy, and diagnostic accuracy. Vents in medical devices are designed to enable venting and pressure equalisation while containing liquids. In numerous healthcare equipment applications, venting and filtration capabilities are critical to the successful operation of the equipment. In demanding applications, effective venting requires high gas permeability. It is the gas permeability of the media that enables high airflow and fast pressure equalisation. Many of the medical device venting applications also require containment or management of challenging liquids that can be hazardous and readily wet out and leak through conventional materials (e.g., blood and body fluids or various drugs including cytotoxic chemotherapeutics). The combination of needs for high gas permeability, high liquid

retention and high particle and/or microbial resistance requires advanced materials like fluoropolymers.

Fluoropolymer-membrane-enabled media is used to vent, filter, and protect non-implantable medical devices such as hearing instruments, ostomy bags, haemodialysis equipment, and intravenous (IV) infusions sets increasing device reliability and patient quality of life.

An additional use category includes rapid diagnostic devices. These include Point of Care diagnostics that utilize microfluidic approaches to prepare, mix, expose, amplify, and measure to achieve an accurate diagnosis. Poor venting causes bubbles or poor fluid movement that impact result accuracy. There are also vented lab-based diagnostic devices which help automate the preparation, staining, cytology, and assay analysis of tissue samples (i.e. oncology). These devices are used to test for infectious disease, genetic testing, and cancer screening.

Gore confirms that we manufacture products that are in the same sub-use as the example used by the DSs to describe the applications of the derogation, namely:

“Fluoropolymer-based membranes with fluorinated sidechain polymer coatings used for (sterile) venting of medical devices, for example cell culture devices, analytical devices, blood tube systems for dialyzer systems, and tube systems for eye surgery”.

To clearly define the applications that should fall under the proposed derogation, we provide below a detailed description of the product and its reliance on PFAS. The product example is a Gore product, as details of comparable products manufactured by other companies are not publicly available. We believe that this product is representative of products manufactured in and placed on the EU market by other companies.

Table 1. Vents used in Non-implantable Medical Devices

Product	Illustration	Description
GORE® Microfiltration Media (Vents) for Medical Devices		Fluoropolymer membrane enabled media used to vent, filter, and protect non-implantable medical devices such as hearing instruments, ostomy bags, haemodialysis equipment, and IV infusions sets, increasing device reliability and patient comfort[1].

These vents are made of fluoropolymers and other PFASs with at least 99% of the PFAS volume meeting the criteria for Polymers of Low Concern (PLCs), under the definition

[1] Gore (2021). GORE® Microfiltration Media for Medical Devices. Available at: https://www.gore.com/products/gore-microfiltration-media-for-medical-devices

provided by the OECD Expert Group on Polymers. [redacted]

[redacted]

[redacted]

III. Reference in the Restriction Proposal

1. Clarification of scope

Gore recognizes that the use of PFAS in medical device applications and the *membranes used for venting of medical devices* sub-use was researched in detail by the Dossier Submitters (DSs) as presented in Annex A Table A.1, page 5 and section A.3.10.1.12. Furthermore, Gore agrees with the assessment in Annex A, Section A.3.10.3, page 91 that the following are critical for medical device applications:

- bio-inertness
- flexibility
- resistance to solvents
- ability to withstand aggressive sterilization procedures
- chemical and temperature resistance

However, the inherent material surface energy enables membranes used for venting of medical devices to contain low surface tension liquids, such as bodily fluids, drug mixtures, and chemicals, and allows venting across the membrane. In addition, Gore will share evidence that alternative materials cannot perform this function under common demanding conditions.

2. Alternative assessment

The alternatives discussion in Annex E (Section E.2.9.2.1, page 322) is limited and cites one stakeholder claiming that technically feasible alternatives are not available. The lack of any other meaningful information resulted in the DSs concluding that the evidence is weak that technically and economically feasible alternatives are not generally available for the quantities required and that the substitution potential is uncertain. Gore agrees with the

cited stakeholder and observes that, despite the inherent incentive to find less expensive alternatives to these high-cost materials[2], no viable alternatives have been identified.

IV.Need and Justification for Derogation

Without a derogation, non-implantable medical devices that vent, filter, and protect would need to use materials that are not capable of fully performing the required functions under typical use conditions. This would decrease the reliability and availability for devices that provide rapid disease diagnosis, effective patient treatments, and improved patient quality of life. We propose that a derogation is justified based on the following points:

- The **performance requirements** for vents used in medical devices
- The **lack of availability of alternatives** that would provide the required level of performance
- The **time required** for research and development to investigate and evaluate potential alternative materials, and if a feasible alternative is identified, the time required to identify develop, test, and commercialize vents for a diverse set of medical devices
- The **extremely low volume of PFAS** needed for this application in comparison to the **large socio-economic cost** of restricting the use

1. Performance and Material Property Requirements

Medical Device Venting applications require the vent material to contain liquids (including both splash protection and while under liquid pressure) while allowing airflow. This allows pressure equalisation and, at the same time, prevents leakage and/or contamination depending on the specific device. Fluids in these applications include bodily fluids, drug mixtures, and chemicals (i.e. IPA, Thiodiglycol, Polyethylene Glycol, Ethanol, Intralipids, etc). Many of these fluids are low surface tension fluids with the ability to spread over surfaces easily (alcohol solutions, fats, diagnostic assays, chemotherapy solutions, surfactants, exudates, etc).

a. Microporous Structure – Ability to Equalise Pressure

The pressure equalisation (airflow) capability of a membrane is determined by multiple factors of which porosity has a large impact. With all other variables fixed, large pores allow more airflow than small ones. At an extreme, a completely non-porous membrane (e.g. having no openings or holes such as a solid sheet) would have no airflow but perfect liquid retention. However, this approach does not provide the needed pressure equalisation to function as a vent in a medical device.

[2] The Restriction Dossier refers multiple times to higher costs of fluoropolymers (Annex E, page 285, 390, 444, 458, 504, …)

The membranes which are used in these vents for pressure equalisation need to be thin and low-mass with mechanical properties and a porous microstructure that enable optimal transmission of air or other gases while also preventing leakage of the contained fluid and/or ingress from liquids on the outside as well as other potential contaminants.

The permeation properties enable the vent structure to rapidly equalise pressure changes or allow gas bubbles to be evacuated from a liquid reagent stream. This is especially important in drug preparation and diagnostics applications. Figure 1 below demonstrates how vents maintain performance.

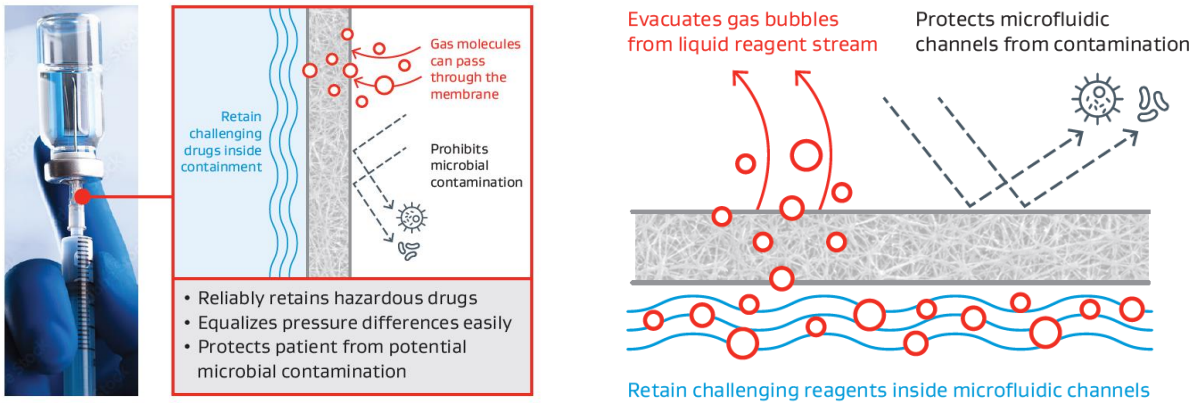


Figure 1. Drug Preparation (left) and Diagnostics (right)

In other applications, the vent is intermittently in contact with a liquid. In these cases, the vent must be able to rapidly recover its ability to equalise pressure and allow gases to pass through the vent. Exposure Recovery (also known as airflow recovery) testing is done to assess the ability of a vent to regain venting performance after exposure to a fluid that temporarily inhibits it.

b. Hydrophobicity and Oleophobicity - Barrier to liquids

For a microporous material to be an effective liquid barrier, its surface energy must be sufficiently low that there is not partial or full wetting from the liquid. A comparative visualization of no “wet-out” vs full wetting can be seen below in Figure 2. When a liquid wets out a microporous membrane, it does not just sit on the surface, but penetrates into the pores, blocks airflow and allows the liquid to leak through the membrane. An example of a wetted material in shown in Figure 2b. In contrast, Figure 2a shows liquid resting on the surface of the membrane and not penetrating into the pores. This is due to the relatively low surface energy of the membrane compared to the surface tension of the liquid.

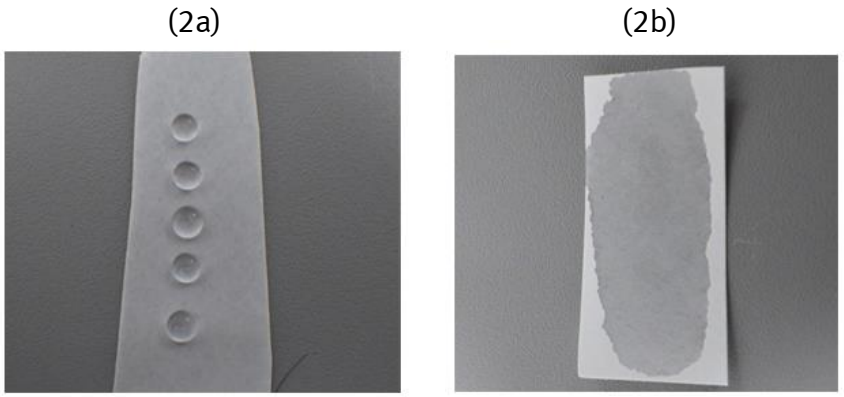


Figure 2. No Wetting (a) and Full Wetting (b)

A key material property that dictates performance in such an application is its inherent surface energy, since the ability to repel liquids is dependent on surface energy. Surface energy is a material property typically used to characterize hydrophobicity (repels water) and oleophobicity (repels water and oils). The lower the surface energy, the more hydrophobic a material is. An extension of hydrophobicity is oleophobicity, which requires even lower surface energy, and enables non-wetting properties with lower surface tension fluids.

Surface energy is assessed using surrogate test fluids for the fluids (blood, fats, etc.) typically used in the medical applications relevant to this derogation. Figure 3 below outlines the ranges of surface tension for these fluids.

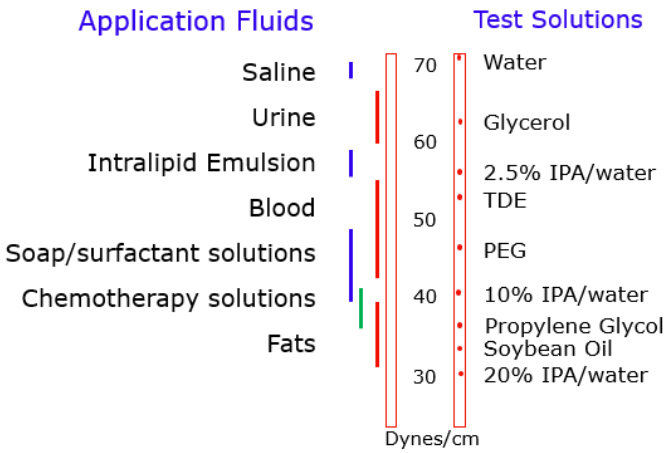


Figure 3. Surface Energy of Application Fluids and Surrogate Test Fluids

Examples of demanding low surface tension fluids [redacted] are evident in pharmaceutical, chemotherapy and diagnostics applications where devices in contact with these substances need to maintain liquid retention, airflow performance, and hemical resistance. These fluids commonly have surface tensions from 28 to 40 dynes/cm.[3]

Liquid barrier performance of material in a venting application can be empirically quantified using Liquid Entry Pressure (LEP), which is the minimum pressure required for a target liquid to penetrate the pores of the membrane and create a "leak path". This is especially important with higher pressure applications, such as IV Drug Infusion, where liquids such as chemotherapy drugs are forced into contact with the membrane to remove air bubbles. Air bubbles injected during IV infusion may reduce therapy effectiveness, increase infusion time, or increase risk of adverse events. If these chemotherapy fluids have a lower LEP and leak, they may be hazardous to clinicians and patients.

c. Chemical resistance and Biocompatibility – Durability in challenging conditions

Depending on the specific end use, there are often stringent requirements which include chemical resistance and applicable biological evaluation tests described in BS EN ISO 10993-4, -5, -10, -11, and -23 as relevant for medical devices. These requirements eliminate many alternatives from consideration. For the purposes of this derogation request, we will focus on the primary functionality of a vent which is sufficient to highlight the lack of alternatives to fluoropolymers and other PFAS in this application.

2. Availability of Alternatives

a. Hydrophobicity and Oleophobicity

Surface energy is a material property which determines its hydrophobicity and oleophobicity. It is a predictor of material suitability for medical device vents. The lower the surface energy, as described by a lower critical surface tension and a higher contact angle with water, the more hydrophobic the polymer - the more it inherently resists water, water borne contaminants, and complex fluids (i.e. oily mixtures). Table 2 contains typical surface energy values for common polymers with some fluoropolymers highlighted in yellow.

[3] Dynes/cm are equivalent to nM/m and will be used interchangeably in this document.

Table 2. Critical Surface Tension and Contact Angle with Water for Various Polymers[4]

Polymer abbr.	Polymer Name	Surface Energy (dynes/cm)	Contact Angles (degrees)
PES	Polyethersulfone	46	90
	Styrene butadiene rubber	48	
PPO	Polyphenylene oxide	47	75
	Nylon 6/6 (polyhexamethylene adipamide)	46	
PC	Polycarbonate	46	75
	Nylon-6 (polycaprolactam)	38	
PET	Polyethylene terephthalate	42	76
PMMA	Polymethylmethacrylate	41	82
SAN	Styrene acrylonitrile	40	74
	Polyimide	40	83
PVC r	Polyvinyl chloride, rigid	39	90
	Polyester	41	70
	Acetal	36	85
ABS	Acrylonitrile butadiene styrene	35	82
PPS	Polyphenylene sulfide	38	87
PVA	Polyvinyl alcohol	37	10
	Polyacrylate (acrylic film)	35	
PVC p	Polyvinyl chloride, plasticized	35	89
PS	Polystyrene	34	72
	Nylon-12	36	
	Surlyn ionomer	33	80
PBT	Polybutylene teraphthalate	32	88
CTFE	Polychlorotrifluoroethylene	31	
PP	Polypropylene	30	88
PU	Polyurethane	38	85
PE	Polyethylene	30	88
PVF	Polyvinyl fluoride	28	
PVDF	Polyvinylidene fluoride	25	80
	Natural rubber	24	
PDMS	Polydimethyl siloxane (silicone elastomer)	23	98
FEP	Fluorinated ethylene propylene	20	98
PTFE	Polytetrafluoroethylene	19	120

PTFE is naturally hydrophobic and has a surface energy of 18-19 dynes/cm. This allows it to easily repel fluids with surface tensions similar to water (about 70-75 dynes/cm), but also liquids that are relevant to demanding medical device applications with lower surface tensions (commonly 28 dynes/cm or lower). **In Table 4 above, Natural rubber and PDMS, while both have relatively low surface energy, cannot be made into microporous membranes, and are therefore not suitable or relevant for venting applications in medical devices. Only fluoropolymers have both sufficiently low surface energy and the ability to be made into durable microporous membranes for these demanding applications.**

Gore test results for Surface Energy and Wetting

The graph below (Figure 4) shows the relationship between Contact Angle and Surface Tension for PTFE (line drawn through circular points) compared to [redacted] (line drawn through triangular points). The downward shift of the curve predicts a worse performance of the alternate material leading to an inability to

[4] https://www.tstar.com/blog/bid/33845/surface-energy-of-plastics

contain the application liquid at application pressures. This will not only lead to liquid breakthrough, but also reduced or eliminated venting performance.

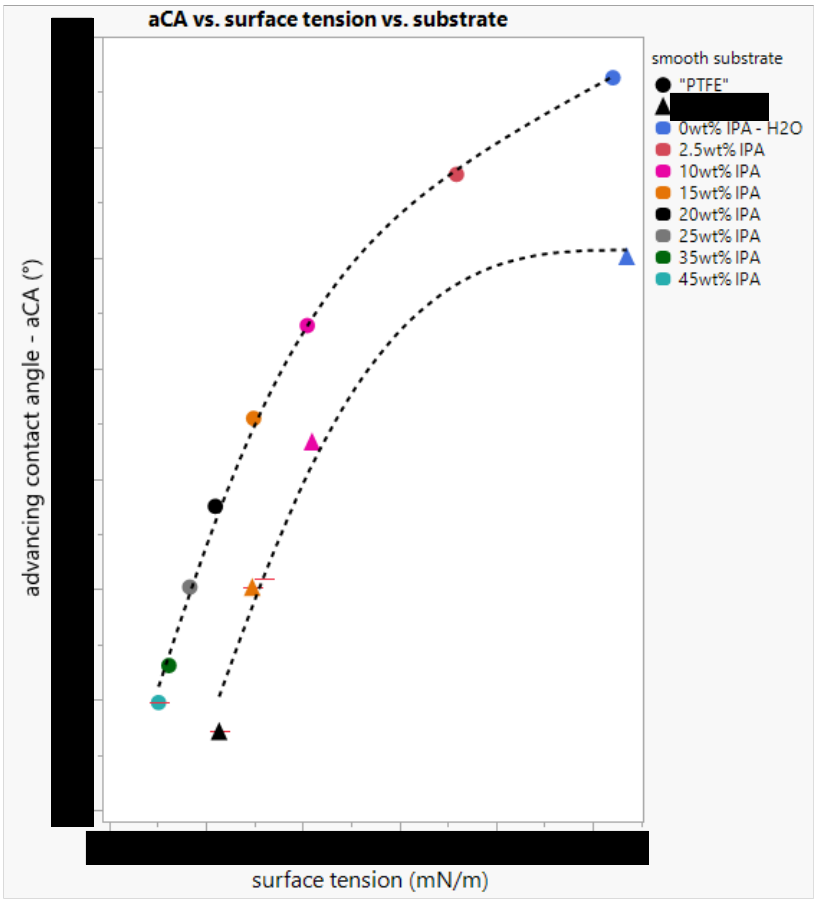


Figure 4. Contact Angle vs. Surface Tension

To “off-set” this downward shift, other parameters in the model equation shown in Figure 7 would have to change. There are no known changes in pore size, pore structure, etc. that would adequately compensate the downward shift in this example which has relatively low surface energy for a non-fluorinated polymer.

A variety of surrogate fluids were investigated to test the full range of surface tensions. The graph below (Figure 5) shows the relationship of surface tension (gold line) to the contact angle on various materials. This relationship trend is consistent on all three materials shown below [redacted].

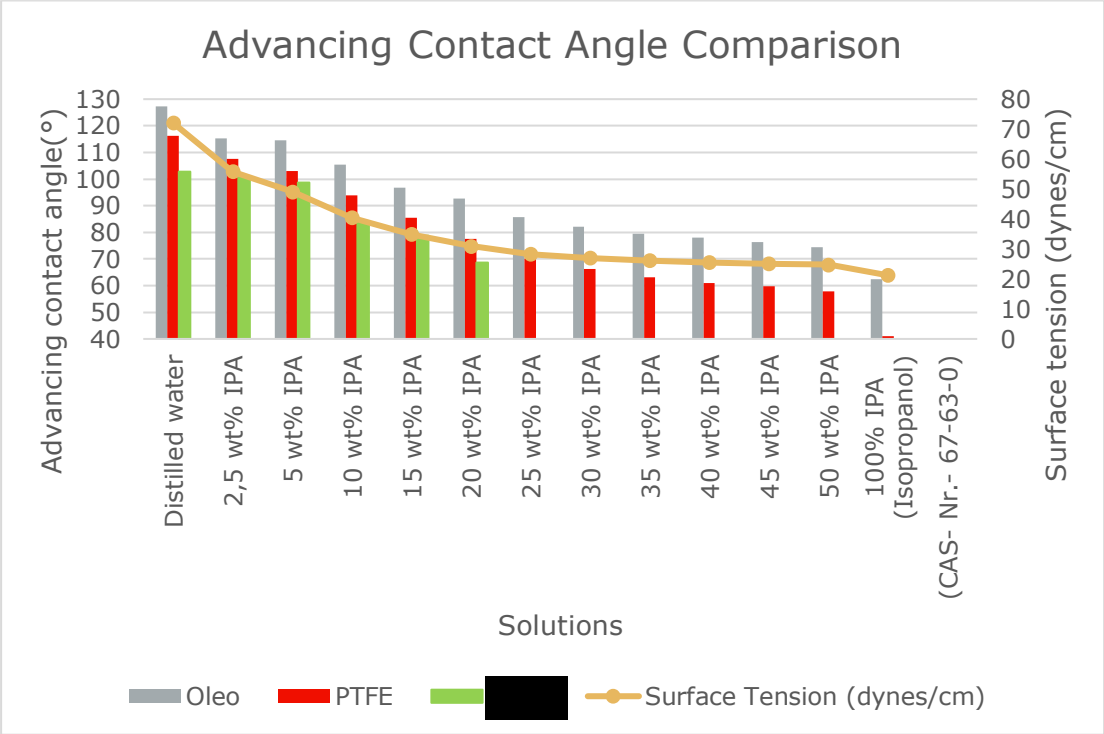
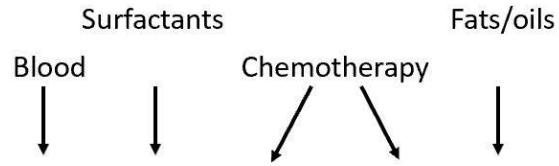


Figure 5. Contact angle depending on solution

Additionally, a study was performed comparing [redacted]. PTFE was the only material found to be non-wetting below 34.47 dynes/cm of surface tension (Figure 6). As indicated earlier, wetting of a porous membrane leads to blocked airflow and leaks.

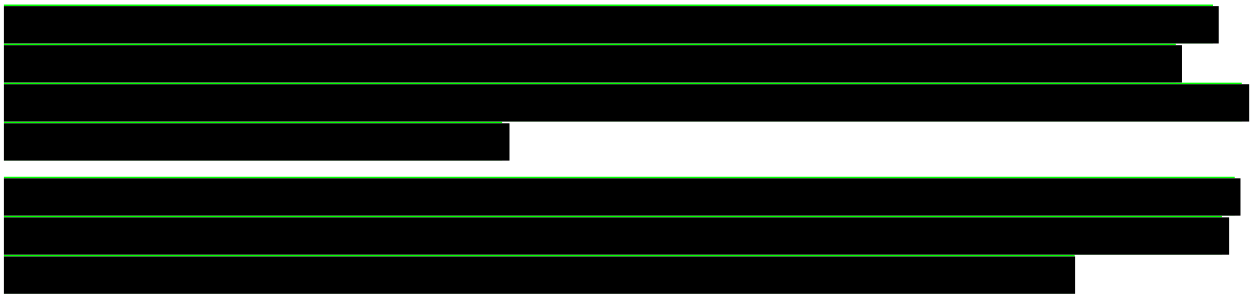


Polymeric Membrane Type	Membrane Format	Item No/Lot. Info	55,63 dynes/cm (2.5 wt% sol.)	48,45 dynes/cm (5 wt% sol.)	39,84 dynes/cm (10 wt% sol.)	34,47 dynes/cm (15 wt% sol.)	29,74 dynes/cm (20 wt% sol.)	27,71 dynes/cm (25 wt% sol.)	26,59 dynes/cm 30 wt% sol.)
ePTFE (0.03)		10141807 / C402502512	non wetting	non wetting	non wetting	non wetting	non wetting	non wetting	non wetting
[redacted]			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	non wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	non wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	full wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	non wetting	non wetting	non wetting	full wetting
			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting
			non wetting	non wetting	non wetting	full wetting	full wetting	full wetting	full wetting

Figure 6. Surface Tension of Various Membranes and Various Complex Solutions

These results confirm that [redacted] are not suitable as venting materials when exposed to low surface tension liquids that are relevant to medical device applications.

[redacted]



[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Alternatives Summary

Material property screening, predictive modelling and experimental results all indicate that fluoropolymers are the only materials suitable to meet the performance requirements of vents in medical devices

3. Timeline

The Restriction Proposal only advises a transitional period of 13.5 years for vents used in medical devices. As pointed out on page 77 of the Restriction Dossier, this is based on the understanding of the Dossier Submitter that 13.5 years are *'normally sufficient for industry to take benefit from technical progress and to carry out scientific R&D activities to find and deploy technically and economically feasible alternatives'*. This assumption is not appropriate for medical devices. It does not accurately take into account the time needed to identify alternative materials, nor the time to develop, test, and commercialize medical devices once an alternative material is identified.

Timelines to develop and validate alternative materials in the highly regulated medical device industry can be significantly longer than in other industries. Material substitution in medical devices is highly complex and involves not only development and testing of materials in the component itself, but also development and testing of the final device which uses the components with its associated technical, clinical, and regulatory processes.

Due to the unique material properties described in the Alternatives Assessment above, Gore, and other key actors in the supply chain, do not believe that alternative materials can be developed to replace fluoropolymers in these applications.

Despite the high cost of raw materials and the inherent incentive to find less expensive alternatives, no viable alternative materials have been identified and developed to date for use in venting in medical devices. We estimate it could take at least another 5-10 years to identify and develop possible alternative polymer materials. This first step involves discovery, for which a specific timeline cannot be predicted. Even with extended timelines, viable materials may not be successful in meeting the stringent requirements of these applications.

Assuming a feasible alternative material can be identified, additional steps in a typical timeline for the development and validation of novel materials for other applications are provided below. To estimate the time required to bring an unknown alternative to market, Gore has divided the effort into several phases:

Phases	**What activities does this step entail?**	**Time required for step**
Discovery	For this application, Gore has shown that invention or breakthrough processing technology is required to develop an alternative. The likelihood of this is low and the timeline is long and unpredictable.	**Unknown** Estimated to be at least 5-10 years
Development	Optimise material for specific medical device applications. This may involve transitioning processes to pilot scale or small-scale manufacturing.	3 years
Production	Investment, installation, and qualification of new mass production capability. Establishing robust material supply chain.	2-5 years
Validation and Commercialization of Vent component	Internal evaluations of material performance and process validations following ISO13485 and ISO15378 quality system requirements.	~2 years
Validate and Commercialization of Device incorporating new vent	This estimate includes final device performance evaluations and process integration validations.	> 3 years
Total		**Unknown** Estimated to be at least 15 to 23 years

4. Ingress Protection Vents are not a Significant Source of Emissions across their Lifecycle

As described in Gore's separate derogation request for fluoropolymers, emissions during processing are negligible thanks to emission control technologies. PTFE and PFA do not erode or off gas, even when exposed to aggressive chemicals or relevant environmental temperatures, which suggests that emissions during service life are negligible.

Additional information on responsible manufacturing, processing and disposal of fluoropolymers, and products made from fluoropolymers, is also provided in Gore's derogation request for fluoropolymers.

5. Socio-economic Impacts

Without a derogation, there will be multiple types of impacts in the EU impacting both quality of healthcare and costs.

a. Safety, Effectiveness and Availability of Medical Devices

By restricting the use of PFAS in membranes used for venting of medical devices, rapid disease diagnosis, effective patient treatments, and patient quality of life would be negatively impacted. Examples include:

- IV infusions – While venting air bubbles, drug infusions, such as chemotherapy, could leak from packaging and infusion systems causing serious hazards to patients and clinicians.
- Drug Transfer – Drugs could clog vents, affecting dosage accuracy and drug loss.
- Diagnostic devices - chemicals needed for successful diagnosis (tissue staining, sample preparation, PCR, etc) may leak in the diagnostic device leading to inaccurate diagnosis, longer wait times to receive critical disease diagnoses, and inability to test for multiple conditions simultaneously.
- Negative Pressure Wound Therapy – The complex and infectious fluids from wound vacuums may leak causing contamination in the vacuum system or blockage, reducing effectiveness of the vacuum (possibly impacting patient outcomes).
- Ostomy bags – The oily environment may clog the vent, requiring the patient to manually open the ostomy bag to routinely reduce air pressure from the waste products, significantly reducing quality of life.
- Battery compartments in non-implantable medical devices – Complex fluids such as blood may clog vents, reducing the ability to vent explosive gases and leading to casing failure.
- Hearing instruments – The waxy/oily environment could clog the vent, reducing the ability to transmit sound.
- Haemodialysis – Infectious fluids from dialysis treatment could leak, causing contamination or breakdown of the clinic's equipment and increased risk of cross-patient contamination.
- Urology – Urine could clog vents or leak, increasing the frequency of bag replacement and reducing quality of life.

b. Financial Impact

A restriction on a critical component in a range of medical devices will also have financial implications to individuals, industry, and governments. Across a range of uses, costs may increase due to:

- More frequent replacement of medical devices due to clogged vents.
- Downstream costs due to delayed diagnoses.
- Increased patient care costs due to lower performance of medical devices.
- Increased costs to manufacture pharmaceutical compounds or diagnostic devices due to the potential for leaks, batch contamination, or other quality issues.
- Increased cost to industry for development, testing and validation of alternate solutions which are demonstrated not to meet all the performance requirements.

Because fluoropolymers and other PFAS are used in many applications related to medical device and pharmaceutical manufacturing, the disruption to supply chains for components that enable safe, effective devices may cause manufacturers to reconsider the best location for manufacturing products sold globally. Broad impacts from a PFAS restriction on the medical device and pharmaceutical manufacturing sectors have been described in a variety of industry group responses to the public consultation, including those from Bundesverband Medizintechnologie (BVMed e.V), BioPhorum, European Federation of Pharmaceutical Industries and Associations (EFPIA), MedTech Europe and others.