PHASEOUT GUIDANCE

Version 01 | 2023

PER- & POLYFLUOROALKYL SUBSTANCES (PFAS)

Purpose

This document serves as a guideline for brands, manufacturers, and suppliers of raw materials and chemicals to align on a common approach and definition for the phaseout of PFAS from materials used in the production of apparel, footwear, accessories, and related products.

It includes a harmonized implementation and verification approach based on supply chain communication, documentation, and laboratory analytical testing.

We encourage value chain actors to use this document to demonstrate the elimination of PFAS and conformity with the current AFIRM RSL.[1] Individual AFIRM member brands may have their own policies and expectations related to PFAS elimination since many have already begun transitioning away from or have successfully completed their phaseouts of certain or all PFAS uses.

What Are PFAS?

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) are synthetic chemicals defined as "fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e., with a few noted exceptions, any chemical with at least a perfluorinated methyl group ($-CF_3$) or a perfluorinated methylene group ($-CF_2-$) is a PFAS."

This definition is provided by the Organisation for Economic Co-operation and Development (OECD) which, along with the United States Environmental Protection Agency (U.S. EPA), defines several thousand substances as belonging to the group of PFAS.[2, 3]

New legislation in, e.g., California and New York, defines PFAS more broadly as "fluorinated organic chemicals containing at least one fully fluorinated carbon atom."[4, 5] Since the current OECD, U.S. EPA, and U.S. state definitions are not harmonized, this guidance and the AFIRM RSL employ the broadest possible interpretation of PFAS (i.e., the U.S. state definition) for purposes of testing and compliance.[6]

Why Are PFAS Restricted?

Many PFAS have been found to cause long-term health effects depending on the level and duration of exposure, including at very low levels. PFAS are often referred to as "forever chemicals" because of their resistance to degradation and resulting persistence in the environment, which is a function of the carbon-fluorine bonds they contain (one of the strongest single bonds in chemistry). Due to their environmental persistence and wide range of hazard traits, authorities around the world are increasingly regulating the entire class of PFAS instead of specific subclasses or individual PFAS. See Table 1 for examples of common terminology related to PFAS.

What Are PFOA, PFOS & PFCs?

PFOA

Perfluorooctanoic acid (PFOA) is a specific PFAS compound identified by the Chemical Abstract Services (CAS) Number 335-67-1. Often referred to as "C8," PFOA is used as an industrial surfactant in chemical processes and as a material feedstock. PFOA, along with Perfluorooctanesulfonic acid (PFOS), was one of the first PFAS compounds linked to human health effects and persistence in the environment, and therefore regulated.

PFOS

PFOS is a specific PFAS compound identified by the CAS Number 1763-23-1. It is a fluorosurfactant and was previously the key ingredient in various fabric protection products. PFOS, along with PFOA, was one of the first PFAS compounds linked to human health effects and persistence in the environment, and therefore regulated.

PFCs

Historically referred to Perfluorochemicals or Perfluorinated Compounds, this chemical class is now broadly referred to as "Perfluoroalkyl and Polyfluoroalkyl Substances" or "PFAS" instead. The term "PFAS" is preferred since "PFCs" is also used in reference to "Perfluorocarbons," which are human-made chemicals composed of carbon and fluorine only, and which are regulated due to being powerful greenhouse gases. Perfluorocarbons are separate and distinct from PFAS compounds, with different properties and hazard traits.

Table 1. Examples of PFAS-related Terms and Statements

This table clarifies common PFAS-related terms and statements that may be found in chemical and material suppliers' marketing materials as well as in brands' product communications.

Term or Statement	Description
Stain-, oil-resistant, or -repellent	Product likely contains or is treated with PFAS
Water-resistant, -repellent, or -proof	Product may contain or be treated with PFAS
PFOA- and PFOS-free*	Product does not contain PFOA or PFOS above specifc very low concentration thresholds. These substances are legally restricted in, e.g., the EU. Products and/or materials with this claim might still contain or be treated with other PFAS.
No PFAS- or PFC-based DWR finishing	Product is not treated with a PFAS-based durable water-repellent (DWR) finish. Sometimes referred to as "C0" by development teams. Inclusion of a PFAS-based membrane like PTFE cannot be ruled out.
PFC-free*	It is still possible to find PFAS in the product. "PFC" might refer to a specific subset of PFAS only.
No intentional use of PFAS	Product is not intentionally treated with PFAS and does not intentionally contain a PFAS-based membrane like PTFE; however, it is possible that PFAS can be detected due to unintended PFAS use in material streams, use of recycled materials that contain PFAS, or other sources of PFAS contamination.
No intentional use of PFAS, and PFAS not detected	Product is not intentionally treated with PFAS, does not contain a PFAS-based membrane like PTFE, and no PFAS can be detected using standardized industry test methods. This is the highest standard and implies alternative treatments, proper chemicals management, and control of contamination and residuals.

* AFIRM strongly discourages use of the term "free" to imply that a product does not contain any specific substance.

Intentional Use Versus Contamination

PFAS are highly persistent, widely used substances, and some are also quite volatile. Consequently, cross-contamination from PFAS-containing materials and contamination from environmental media are common.

Even with the robust manufacturing control programs AFIRM member brands use to manage chemicals in their supply chains and products, PFAS may still be found above practical quantitation limits (PQLs) in materials that were not intentionally treated with PFAS and do not include PFAS-based membranes like Polytetrafluoroethylene (PTFE).[7] This issue has been illustrated in media coverage and NGO product testing and advocacy, and it will be amplified as industry transitions to more circular business models by utilizing increasing amounts of post-consumer recycled content.

PFAS contamination above regulated limits may still be found in materials processed or handled in facilities that have completely eliminated intentional use of PFAS. Therefore, a successful phaseout of PFAS from the entire apparel and footwear value chain will only be possible by eliminating their use from all relevant manufacturing processes. Considering the persistence of PFAS, this is an ambitious goal that requires international collaboration and sufficient time to fully achieve.

AFIRM recommends that suppliers phase out PFAS entirely to avoid product testing failures; see Appendix A, however, for recommended manufacturing practices to avoid cross-contamination in facilities that may still utilize PFAS for other clients.

Enamels, Coatings, and Paints
Various enamels, coatings, and paints used on hard and soft surfaces of trim components (e.g., zippers and labels) may contain PTFE or other PFAS to increase durability.

Communicating & Implementing PFAS Elimination from Products

AFIRM member brands recommend the following best practices.

Steps for Brands

1. Communicate your intention to eliminate PFAS to your upstream suppliers, making sure to identify any specific timeframes and expectations, i.e., the standard(s) to which they will be held. AFIRM recommends adherence to the current AFIRM RSL to ensure compliance with divergent PFAS regulations across all international markets.
2. Prioritize identifying materials and/or products that are considered stain- or oil-repellent/resistant, water-repellent/resistant/proof, quick-dry, or have breathable membranes that remove or provide a barrier against moisture.
3. If a material or product has any of these performance attributes, work with your suppliers to identify the type of finish, membrane, and/or coating that has been used, since there is a high probability they contain PFAS.
4. Ask your suppliers to provide up-to-date safety data sheets (SDSs) and technical data sheets (TDSs) for all chemical formulations used, particularly any finishing chemistry. Terms like “C4,” “C6,” “C8” and the prefix “fluoro-”, among others, are significant indications of PFAS. Some chemical product labels, however, might include only the generalized name (i.e. “acrylate”). Note that PFAS not classified as hazardous might not be listed in an SDS;[8] therefore, as a final communication step, proceed to #5.
5. Ask your suppliers to provide evidence and/or a written statement from their upstream chemical and material suppliers that PFAS substances, including membranes like PTFE, are not present in their materials or chemical formulations and are not formed during manufacturing.
6. Follow the steps — or ask that material suppliers follow the steps — in the “Recommended Testing Approach” section of this document to verify that PFAS are not present in concentrations that exceed AFIRM RSL restriction limits.

Steps for Material Suppliers

1. Ask your chemical suppliers to provide a durable water-repellent/resistant/proof (DWR) or stain/oil-repellent/resistant finish that does not contain and is not based on PFAS.
2. Notify your downstream customers if a material is considered stain/oil-repellent/resistant, water-repellent/resistant/proof (DWR), or quick-dry and what type of treatment (finish, coating, membrane, or other) you plan to use.
3. Collect and share up-to-date SDSs and TDSs for all chemicals used in your manufacturing facility, such as finishing mixtures, mold sprays, machinery lubricants, cleaning agents, etc. None of these should indicate the presence of PFAS. Note that PFAS not classified as hazardous might not be listed in SDSs,[8] therefore ask your chemical suppliers to confirm that all chemical formulations do not contain PFAS and are not based on PFAS chemistry.
4. Test your materials or products using qualified third-party laboratories according to steps in the “Recommended Testing Approach” section of this document. There is currently no single test method available that can both validate compliance with all global PFAS restrictions and validate that PFAS were not intentionally used. Therefore, AFIRM recommends a combination of two testing approaches and associated methods.

Industry Resources

The tools and resources listed in Table 2 may be useful to material suppliers, brands, and stakeholders for identifying chemical formulations and materials that do not contain and are not based on PFAS.

This list is not exhaustive; there may be other relevant tools, resources, and certification schemes, including individual brand lists of preferred PFAS alternatives. Brands and suppliers should confirm directly with any third-party certifiers that their certification schemes require the complete phaseout of PFAS consistent with the definitions provided above, including Fluoropolymer like PTFE, since details and timelines adopted by each certifier vary.

To prevent regrettable substitutions, AFIRM recommends performing a full chemical hazard assessment when evaluating PFAS substitutes if not already performed as part of a third-party certification system included in Table 2. GreenScreen and ChemForward are examples of reputable third-party hazard assessments that several AFIRM member brands utilize wholly or in part, but others are also available.

Table 2. Tools and Resources

Bluesign®	The bluesign® FINDER includes over 20,000 third-party verified, commercially available textile dyes and auxiliaries. As of July 2023, all existing bluesign® approved PFAS-containing formulations will be removed from the bluesign® FINDER. As of July 2024, all bluesign® approved fabrics treated with PFAS formulations will be removed from the bluesign® GUIDE.
GreenScreen Certified™ Standard for Textile Chemicals	The GreenScreen Certified™ Textile Chemicals v.2.0 standard now includes the entire class of PFAS. All three levels of certification (Bronze, Silver and Gold) require full product inventory and compliance with the GreenScreen RSL, and therefore cannot contain intentionally added PFAS.
Oeko-Tex®	OEKO-TEX® has issued a general ban on PFAS in textiles, leather, apparel, and footwear. To assist with the ban, OEKO-TEX® programs rely on testing for harmful substances and target finished components/products (STANDARD 100, LEATHER STANDARD) and chemicals management in factories (STeP). In addition, OEKO-TEX® evaluates and certifies more than 21,000 apparel/footwear/textile/leather chemical formulations (ECO PASSPORT). Chemicals and certified components can be found on the open resource Buying Guide.
ZDHC Manufacturing Restricted Substances List (MRSL) & ZDHC Gateway	The ZDHC MRSL v3.0 includes the entire class of PFAS. Material suppliers can source chemical formulations that are conformant to the ZDHC MRSL v3.0, and/or search on the ZDHC Gateway for Gateway-registered formulations that are conformant to ZDHC MRSL v3.0. Note that formulations conformant to the MRSL v2.0 may still contain PFAS or be based on PFAS chemistry.

Recommended Testing Approach

This guidance recommends a methodology for testing that combines two general analytical approaches, each with two comparable standardized methods included in the AFIRM RSL (Table 3). These methods for performing PFAS analysis[9] are the most widely available among international commercial testing laboratories and come with advantages and disadvantages.

Table 3. Test Methods Available at Scale

Method 1 : Total Fluorine	Method 2 : Organic Solvent Extraction
EN 14582:2016 or ASTM D7359:2018	EN ISO 23702-1 or EN 17681-1:2022 & 17681-2:2022
• Screening method that provides indication of the presence of any Fluorine. • Does not differentiate between inorganic and organic Fluorine. • Does not provide information on the specific Fluorine compounds present. (Total Fluorine content is not the same as PFAS content.) • Best detection limit among global commercial labs is generally 20 ppm;* however, AFIRM specifies a reporting limit of 50 ppm since this is consistently testable across the international commercial lab networks. • Not sufficient to demonstrate compliance with legally regulated PFAS included in the AFIRM RSL; trace amounts of specific PFAS may be present above AFIRM RSL limits without exceeding the 50 ppm reporting limit for Total Fluorine or the 100 ppm regulated limit beginning in 2025.	• Quantitative analysis for specific PFAS substances. • Very selective; reference standards not available for most PFAS. • Harmonized methods to demonstrate compliance with legally regulated PFAS included in the AFIRM RSL. • Low detection limit (10 – 100 ppb) for targeted analytes. • List of target analytes may differ between labs due to availability of reference standards and other factors. • Not a guarantee that PFAS have not been used in production or that PFAS are not present in the sample as contamination: PFAS which are not specifically analyzed may still be present.**

* Some commercial labs with specialized equipment may be able to reliably measure lower concentrations, but the majority of international commercial labs do not yet have this ability.

** Appendix B of the AFIRM RSL covers the main analytes to expect to find if PFAS chemistry has been intentionally used or if there is significant contamination. AFIRM recommends this harmonized list of PFAS analytes for which to test, quantify, and generate results in test reports.

Defining Acceptance Criteria for Total Fluorine Screening

While intentional use of PFAS is likely to result in concentrations of several thousand parts per million (ppm) Total Fluorine, early screening results for apparel and footwear indicate that Total Fluorine content may be several hundred ppm in samples that have not been intentionally treated with PFAS.

It may not be possible to definitively identify the source of Fluorine in such samples, since it could be present due to PFAS contamination or the presence of non-PFAS Fluorine-containing compounds such as various salts used in textile processing.

In alignment with technical experts and new regulation, AFIRM currently recommends an initial acceptance limit of 100 ppm Total Organic Fluorine to demonstrate no intentional PFAS use. This limit aligns with new legislation in California restricting Total Organic Fluorine to 100 ppm in apparel and footwear by 2025 and 50 ppm by 2027. AFIRM may revise this recommendation in the future as more data become available or as required to ensure compliance with new regulation.

Methods EN 14582:2016 and ASTM D7359:2018 utilize a combustion process of the entire sample. At the time of publication of this guidance, techniques employed within global commercial lab networks are unable to accurately and reliably distinguish between organic and inorganic Fluorine. Chemical formulations utilizing inorganic Fluorine compounds, e.g., Fluoride salts, are used in textile manufacturing processes, and therefore results of Total Fluorine testing will represent both inorganic Fluorine and organic Fluorine, the latter likely present due to PFAS.

Because there is no comprehensive quantitative data set available to demonstrate the typical concentration ranges of total inorganic Fluorine present in apparel and footwear, it is difficult to interpret the results of Total Fluorine testing. Detected Fluorine concentrations should therefore not be assumed to represent exclusively PFAS. It is critical that a harmonized and validated method be developed to isolate inorganic from organic Fluorine, since restricting Total Fluorine may be unnecessarily prohibitive of other Fluorine-containing compounds that are not PFAS.

AFIRM recommends applying a 100 ppm limit on Total Fluorine until a validated method for determining Total Organic Fluorine becomes widely available.

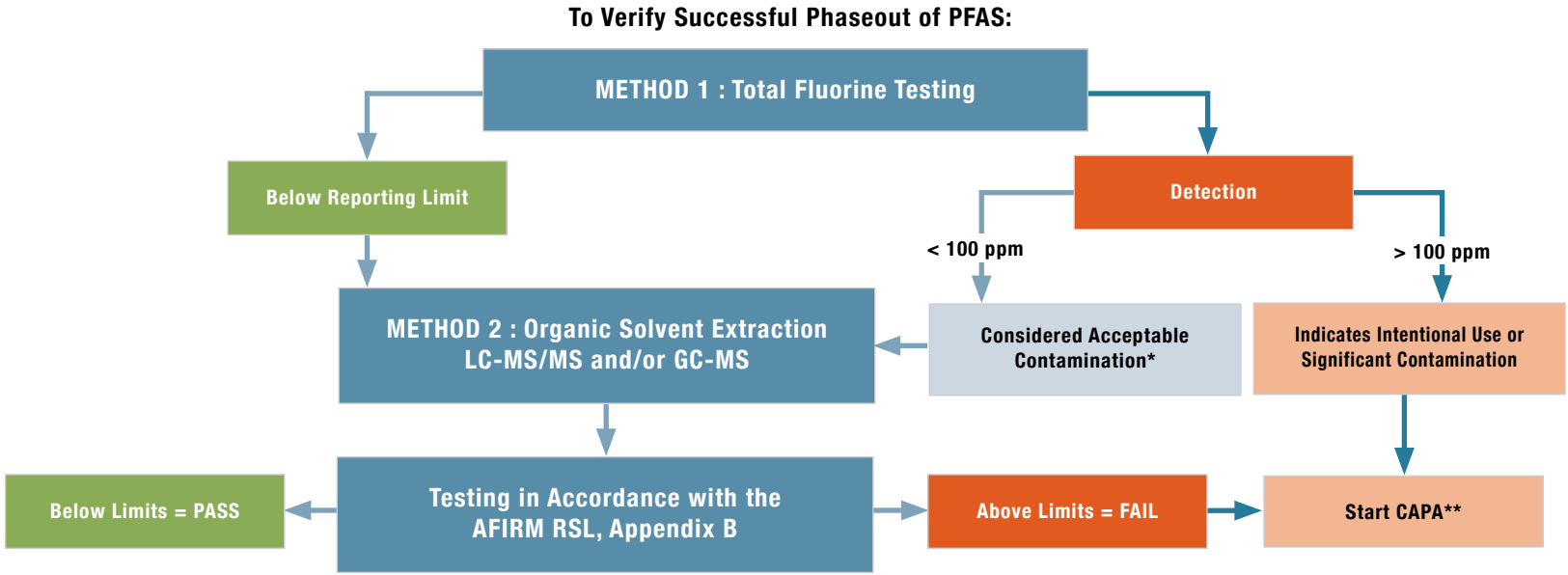
Verification of Successful PFAS Phaseout

To demonstrate compliance with existing EU legal restrictions on PFAS, required testing incudes EN ISO 23702-1 or EN 17681-1:2022 & 17681-2:2022.

The figure shows a testing path using both test approaches to validate successful phaseout of PFAS and compliance with all international regulations.

Figure 1. Test Methods for PFAS

Test method 1 is conducted to ascertain compliance with legislation setting limits on total organic Fluorine (e.g. California AB 1817). Test method 2 is conducted to ascertain compliance with restrictions on specific PFAS compounds and subclasses in the EU under REACH and the Persistant Organic Pollutants (POPs) Regulation. See Appendix B of the AFIRM RSL for a list of specific analytes for which to test and report results.



* Check with your brand customers for their specific requirements regarding PFAS contamination as determined by Total Fluorine analysis. By 2027, this limit will drop to 50 ppm in accordance with California AB 1817.

** Corrective and Preventative Actions

APPENDIX A. Avoiding PFAS Cross-Contamination In Manufacturing Facilities

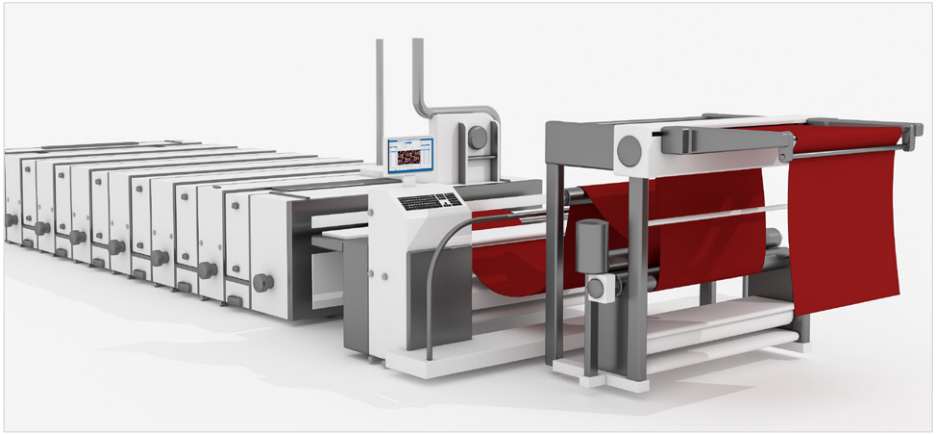
AFIRM highly recommends that facilities producing apparel, footwear, accessories, and related products completely phase out the use of PFAS due to their persistence and the high likelihood of cross-contamination of products intended to comply with AFIRM RSL requirements.

If PFAS chemistry cannot be avoided, production lines using PFAS should be completely separated from production lines for articles where PFAS are restricted. In the event that PFAS chemistry cannot be avoided and separate lines are not available, AFIRM recommends the following instructions for each type of wet process.

Continuous Padding Process Application

Water- and oil-repellents based on PFAS are usually applied with a continuous process: first padding then drying and finishing the fabric with a drier system. This process is commonly performed in a stenter machine, where padding is located at the beginning and the drying is performed afterwards in drying chambers.

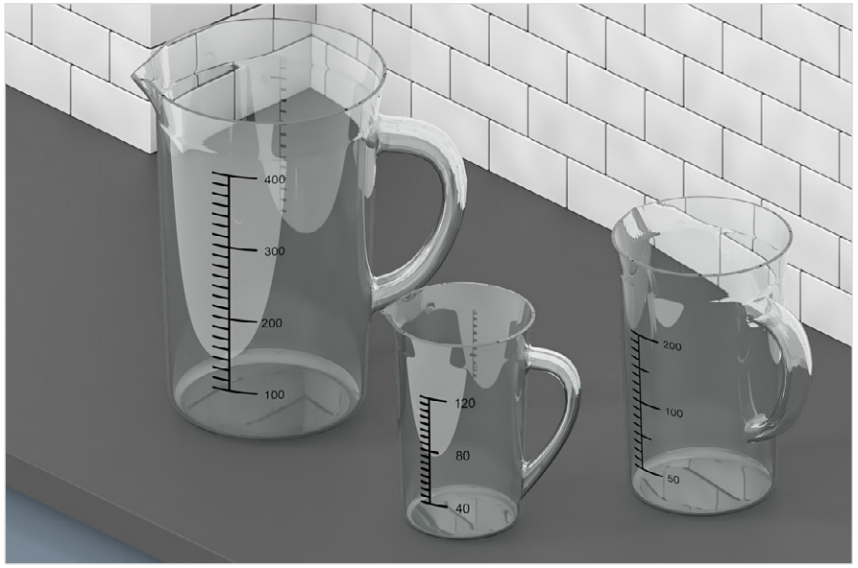
Mills using PFAS chemistry both in the padding process and stenter drying process will have highly contaminated equipment after a production run.



Conventional stenter

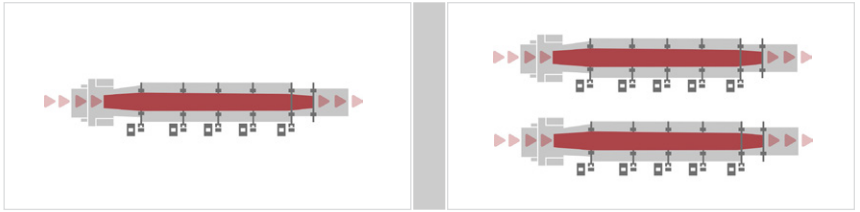
To avoid cross-contamination:

1. For PFAS chemicals, use exclusive manufacturing tools including jars, spoons, weighing accessories, etc. Never use these accessories for non-PFAS production processes.



Accessories commonly used for auxiliary chemicals manipulation.

2. Have a separate PFAS manufacturing production line with a dedicated padding and stenter machine.

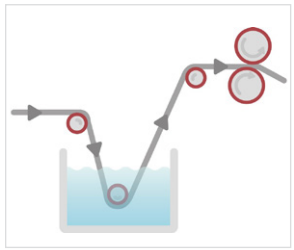


Stenter 1: PFAS-free chemicals

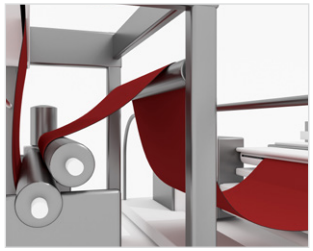
Stenter 2: PFAS-based chemical products
Stenter 3: PFAS-based chemical products

3. All parts of a mill must be thoroughly cleaned if there is only a single padding and stenter machine, including the chemical adding tank, the padding, and all metallic tubes that come in contact with fabric. The best option for cleaning is using a water pressure device such as a spray-gun.

Portable tank for chemical products



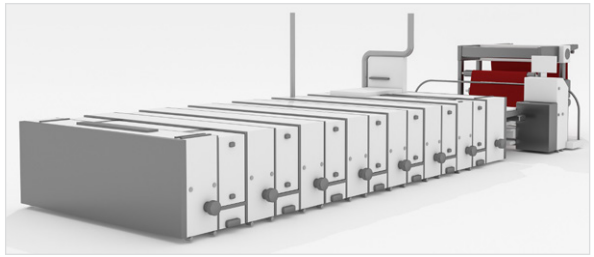
Outline of padding machine



Metallic rolls

4. Extra or waste fabric without PFAS should be fed through all devices (padding and stenter) before any new production of non-PFAS fabric. This fabric will help clean the machinery but must be immediately/safely discarded to prevent new cross-contamination of the equipment.

5. On a weekly basis, clean the stenter extraction system and perform maintenance to ensure its proper functioning for elimination of volatile compounds.



Example of extraction system in stenter

6. AFIRM recommends against applying PFAS-based products by pad-dry and then drying in a stenter. The pad-dry machine will become heavily contaminated if not cleaned thoroughly.

7. Stenters that include built-in padding should be used to avoid splitting production across different machinery, which increase chances of cross-contamination.

Exhaust Process Application

Water- and oil-repellents based on PFAS may also be applied by a fabric exhaust process, which typically involves use of a jet machine. After the application process, a hydro-extraction step needs to be performed before the fabric is finished in the stenter.

Conventional jet machine

Hydro-extractor machine

To avoid cross-contamination:

1. Have all manufacturing accessories used for PFAS chemicals clearly identified/ labeled, including jars, spoons, weighing accessories, etc. Those accessories should never be used for non-PFAS production.

2. Do not use all jets for applying PFAS-based chemical finishing. Nominate a single jet to perform manufacturing processes containing PFAS. An exhaust cleaning process should be performed after every application.

3. After the application process is performed, select specific transportation devices or trolleys for transporting fabric to the hydro-extraction machine. Do not use them for non-PFAS production lines.

4. If there is more than one hydro-extraction machine in the mill, only one of them should be dedicated to PFAS manufacturing processes while saving others for non-PFAS production.

5. After the hydro-extraction process is performed, a cleaning process should be performed.

6. For the stenter finishing process, follow the same good manufacturing process explained in the continuous padding process application section.

Finishing Application On Garments

In some cases, finishing treatments can be applied directly in manufactured garments. Nominate and use exclusive machinery (garment dyeing machine, tumbler dryer, spin drying machine and laundry trolley). Perform thorough cleaning in case it is not possible to use separate machines.

Endnotes

1 Apparel and Footwear International RSL Management Group Restricted Substances List (AFIRM RSL)
http://afirm-group.com/afirm-rsl

2 OECD Portal on Per and Poly Fluorinated Chemicals
https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals

3 CompTox Chemicals Dashboard
https://comptox.epa.gov/dashboard/chemical-lists/PFASMASTER

4 Bill text: California AB-1817 Product safety: textile articles: perfluoroalkyl and polyfluoroalkyl substances.
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1817

5 New York Environmental Conservation Law Section 37-0121: Prohibition against the use of perfluoroalkyl and polyfluoroalkyl substances in apparel and outdoor apparel for severe wet conditions.
https://www.nysenate.gov/legislation/laws/ENV/37-0121

6 There are textile dyes containing organic fluorine that are not considered PFAS under the OECD definition, but are considered PFAS under the newest definition included in, e.g., California and New York legislation.

7 Polytetrafluoroethylene (PTFE) is a synthetic fluoropolymer of tetrafluoroethylene. It has numerous applications and is one of the best-known and widely applied PFAS.

8 Safety data sheets are often incomplete and inaccurate. AFIRM recommends caution relying on them and to confirm with chemical suppliers that they are complete, up to date, and accurate.

9 Other test methods for use in analyzing consumer products and environmental media may be referenced in the scientific literature. This guidance only considers methods that are available at scale from global commercial testing laboratories for use in analyzing PFAS in textile, leather, and other materials used in apparel, footwear, and related products.

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