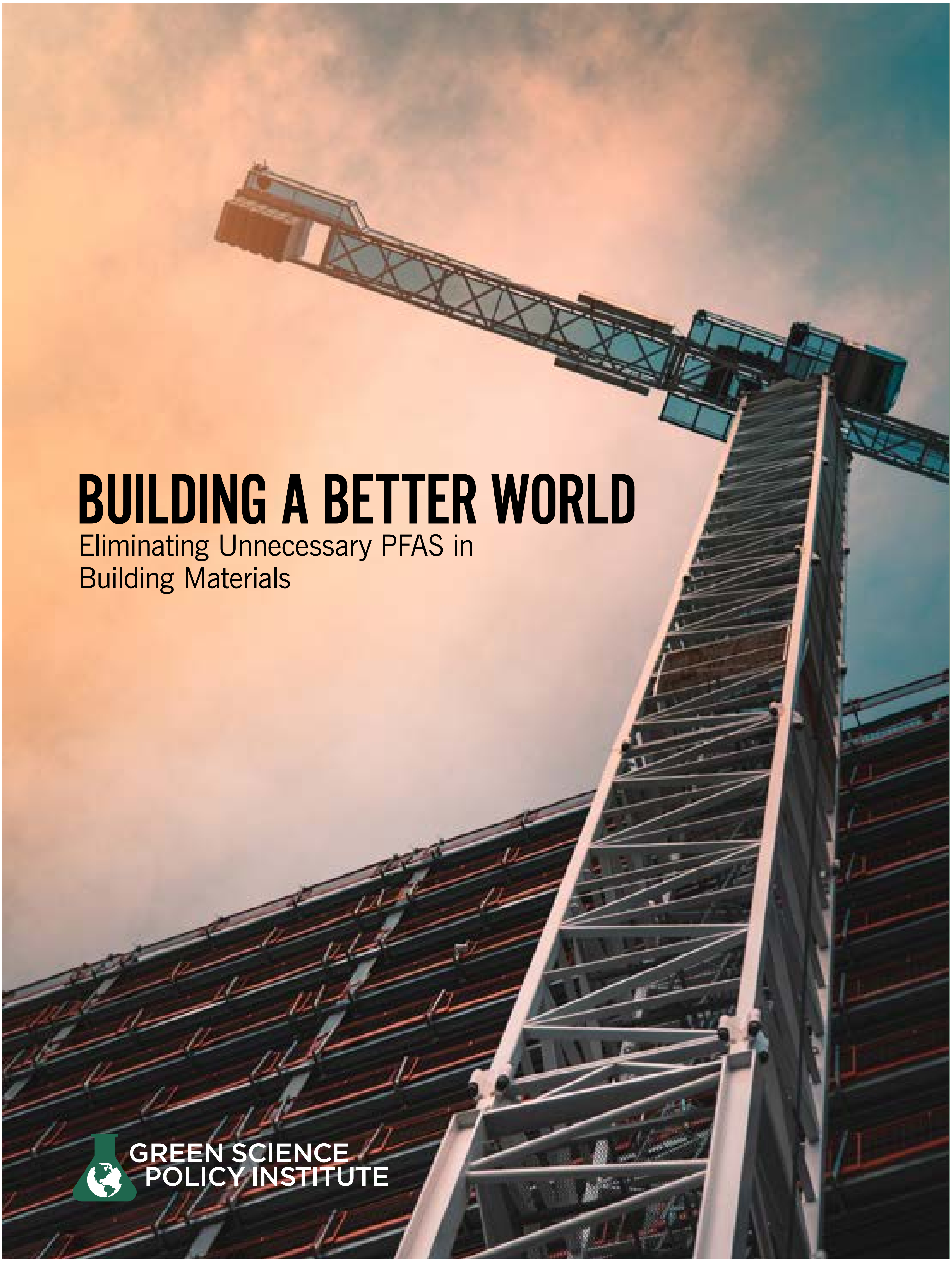

BUILDING A BETTER WORLD

Eliminating Unnecessary PFAS in Building Materials

GREEN SCIENCE POLICY INSTITUTE

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This report was developed by the Green Science Policy Institute, whose mission is to facilitate safer use of chemicals to protect human and ecological health.
Learn more at www.greensciencepolicy.org

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THE BUILDING INDUSTRY HAS THE WILL AND THE KNOW-HOW TO REDUCE ITS USE OF PFAS CHEMICALS. UNDERSTANDING WHERE PFAS ARE USED AND FINDING SAFER ALTERNATIVES ARE CRITICAL.

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EXECUTIVE SUMMARY

Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals that are useful in many building materials and consumer products but have a large potential for harm.

Several well-studied PFAS have been linked to adverse health effects.[1-3] However, most of the thousands of PFAS in commerce have not been studied for their possible health harm.

SCIENTISTS, CONSUMERS, AND GOVERNMENTS ARE CALLING FOR THE RESTRICTION OF PFAS TO ONLY ESSENTIAL USES.

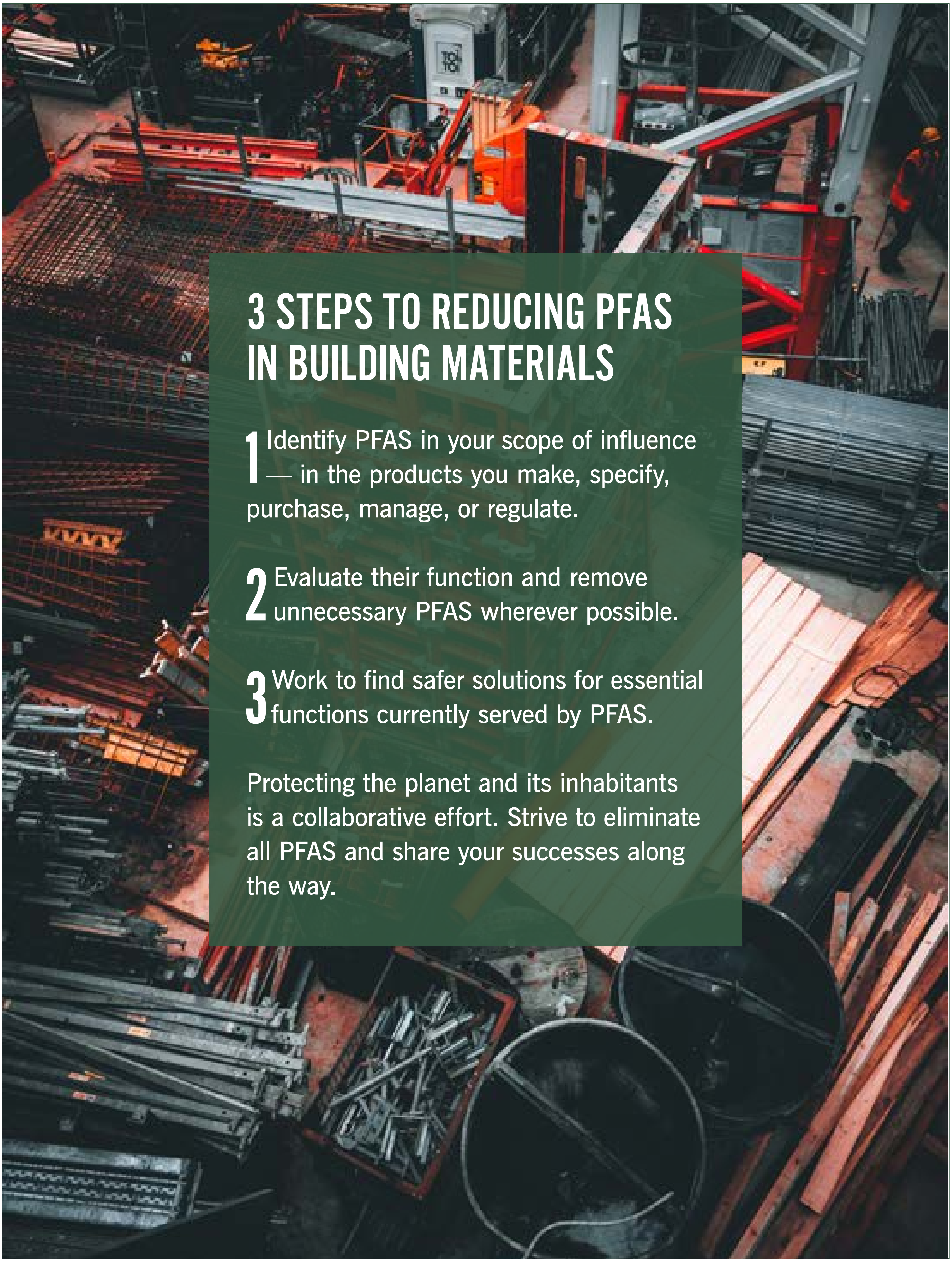
A primary problem is that PFAS are extremely resistant to breakdown and persist indefinitely in the environment.

Continued production and use of these "forever chemicals" will increase the quantity and distribution of PFAS around the globe, and also the risk of harm.

In response to environmental concerns, the fluorochemical industry has transitioned to newer forms of PFAS that it says are safer. Emerging research shows that the replacement chemicals can be as harmful as those they are replacing.[4] Meanwhile, scientists, consumers and some governments are calling for limits on the production and use of all PFAS, except when those uses are truly essential.[5]

The use of PFAS in consumer goods such as food packaging and outdoor clothing is well known. However, the prevalence of PFAS in building materials has received little attention. This report is the first to document that PFAS, including fluoropolymers, are used for a wide variety of applications in the building sector. These include roofing materials, paints and coatings, sealants, caulks, adhesives, fabrics, and more. The diverse uses of PFAS in building materials are discussed in detail, along with scenarios that demonstrate how workers and the public could be exposed.

Safer non-fluorinated alternatives exist for many applications of PFAS in building materials. The incentive to use them and to develop additional safer substitutes is increasing due to pressure from governments and the marketplace. The tools the building industry needs to take on this work—transparency programs, chemical data systems, and certifications—are increasingly available. The goal of this report is to inform and inspire building owners, architects, designers, building product manufacturers, and government decision makers to eliminate unnecessary uses of PFAS and to promote the design and use of safer non-PFAS alternatives.



3 STEPS TO REDUCING PFAS IN BUILDING MATERIALS

1 Identify PFAS in your scope of influence — in the products you make, specify, purchase, manage, or regulate.

2 Evaluate their function and remove unnecessary PFAS wherever possible.

3 Work to find safer solutions for essential functions currently served by PFAS.

Protecting the planet and its inhabitants is a collaborative effort. Strive to eliminate all PFAS and share your successes along the way.

INTRODUCTION

PFAS provide desirable functions such as weatherproofing, corrosion prevention, and friction reduction. However, their utility comes at a cost to health and the environment.

Our built environment has improved tremendously over the past century with the use of synthetic (human made) chemicals and products. However, scientists have discovered that many of these chemicals can migrate from products into the environment and our bodies, and cause harm. Making informed substitutions or avoiding certain chemicals altogether can result in products that are healthier for people and the planet.

Per- and polyfluoroalkyl substances (PFAS) are a large class of synthetic fluorine-containing chemicals with many uses in the building industry, including in roofing materials, paints and coatings, sealants, caulks, adhesives, fabrics, and more.[6] According to the American Chemistry Council, PFAS-containing building materials are a more than $26 billion market.[6]

This class of chemicals provides desirable functions such as weatherproofing, corrosion prevention, lubrication, friction reduction, and grease and water resistance. However, PFAS last a very long time in the environment, up to centuries or more, and can accumulate in soil and water. Some PFAS can bioaccumulate in humans and other living organisms, allowing them to build up to levels at which they can be harmful. In fact, health studies of some PFAS show them to be hazardous to humans and wildlife. Some PFAS are also highly mobile and can move through water or air to become dispersed across the globe. Most PFAS have not yet been studied for their potential harmful effects, but what is certain is they will persist on the planet for many years, exposing humans and the environment to potential harm. While we don't know everything about every individual PFAS, we do know enough about the class as a whole to warrant precautionary action.

PFAS in drinking water and in consumer products are the focus of increasing concern for businesses, governments, and citizens. In some areas, great strides have been made to eliminate unnecessary uses of PFAS. For example, when KEEN® Footwear assessed their product lines and found one hundred uses of PFAS, they determined that 70% of these were not needed and they quickly removed them. Careful evaluation of the remaining uses allowed KEEN to find safer substitutes.* As of 2020, KEEN's work has prevented over 150 tons of PFAS from being released into the environment.

Uses of PFAS in the building industry have received less attention. In this report, we describe the various uses of PFAS in building materials, discuss alternatives, and propose a path forward to identifying and eliminating non-essential uses of this chemical class. We are all stakeholders in the health of the planet and its inhabitants, and together we can raise the standard of care across the building industry, to create healthy indoor and outdoor environments for all.

*Hear KEEN's story: https://youtu.be/AaCXAawdH9k.

LIST OF ABBREVIATIONS

ECTFE: ethylene chlorotrifluoroethylene
ETFE: ethylene tetrafluoroethylene
FEP: fluorinated ethylene propylene
FEVE: fluoroethylene vinyl ether
HFP: hexafluoropropylene
PCTFE: polychlorotrifluoroethylene
PFAS: poly- and perfluoroalkyl substances
PFOA: perfluorooctanoic acid
PTFE: polytetrafluoroethylene
PVC: polyvinyl chloride
PVDF: polyvinylidene fluoride
PVF: polyvinyl fluoride
TFE: tetrafluoroethylene
VDF: vinylidene fluoride

BACKGROUND

PFAS—which contain a basic structure of a chain of carbon atoms surrounded by fluorine atoms—do not occur in nature. The high strength of their carbon-fluorine bonds makes PFAS very stable and gives them the unique ability to repel both oil and water. Thousands of different PFAS have been developed for use in industrial and consumer products including paper, clothing and other textiles, plastic articles, cookware, food packaging, electronics, and personal care products.

Fluoropolymers are large PFAS molecules composed of numerous fluorinated monomers attached together (see sidebar). In some fluoropolymers the repeating unit contains a single type of monomer. Others, called copolymers, are made of repeating units of two or more different monomers. Fluoropolymers may contain other types of PFAS as residuals and impurities leftover from the manufacturing process. These residuals and impurities include smaller, non-polymer PFAS molecules that can migrate out of the fluoropolymers and into the environment. Some of these compounds are well known PFAS, like perfluorooctanoic acid (PFOA) and GenX*. Compared to fluoropolymers, the small size of these residuals and impurities makes it easier for them to enter living cells and cause harm.[7]

The most widely known fluoropolymer is polytetrafluoroethylene (PTFE; also known as Teflon®). First discovered in the late 1930s,[8] this material has become synonymous with "non-stick". The 1950s saw increased use of PTFE and other fluoropolymers in wire and cable insulation, tapes, seals, filters, laminates, coatings and many more applications that required resistance to water, oil, harsh chemicals, and flames.[9] Over the next several decades the uses of fluoropolymers expanded rapidly to include specialized films, fabrics (e.g GoreTex), resins, and more. Current demand for fluoropolymers is greater than 200,000 tons per year and expected to grow.[9]

*GenX is a trademark name for the ammonium salt of hexafluoropropylene oxide dimer acid (HFPO-DA) fluoride.

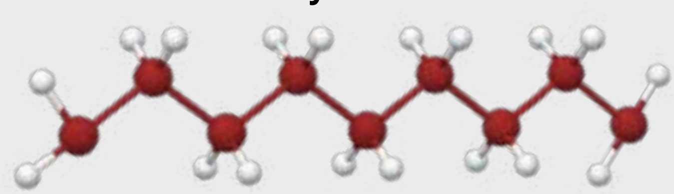
FLUOROPOLYMERS

Fluoropolymers are large compounds containing a carbon-only backbone with fluorine atoms attached directly to it.

Monomer

Monomers consist of a single, often small unit.

Polymer



Polymers contain repeated subunits.

Partial List of Fluoropolymers Used in Building Materials

ETFE: Ethylene tetrafluoroethylene
FEP: Fluorinated ethylene propylene
PCTFE: Polychlorotrifluoroethylene
PTFE (Teflon): Polytetrafluoroethylene
PVDF (Kynar): Polyvinylidene fluoride
PVF: Polyvinyl fluoride

PFAS IN HUMANS AND THE ENVIRONMENT

PFAS make their way into the environment throughout their lifecycle, from manufacturing, through chemical or product use, to disposal. Known sources of environmental releases include industrial sites that produce or use PFAS; airports, military bases, and other users of firefighting foam; landfills; and wastewater treatment plants. Even consumer products such as make-up and rain jackets shed measurable amounts of PFAS to the environment.[10,11]

Measuring PFAS was challenging prior to the late 1990s. As new detection tools became available, scientists began to find PFAS everywhere they looked. PFAS are now detected in water, food, air, and indoor dust,[12-14] all of which lead to human exposure. PFAS have been detected in the bodies of nearly every human tested.[15,16] Certain populations such as firefighters and communities with contaminated drinking water are more highly exposed.[17,18]

Documented adverse health effects include kidney and testicular cancer, elevated cholesterol, liver disease, decreased fertility, thyroid problems, and other health problems.

HEALTH HAZARDS OF PFAS

As early as the 1960s, testing conducted by manufacturers linked certain PFAS to health harm in laboratory animals. Independent research on health effects did not begin until the late 1990s. Since then, numerous studies have evaluated the toxicity of certain PFAS and found associations between increased exposure and several health problems. Understanding the full suite of potential health effects of PFAS is challenging because they can affect many different organ systems and act by a variety of mechanisms. Adverse health effects—particularly for PFOA—include kidney and testicular cancer, elevated cholesterol, liver disease, decreased fertility, thyroid problems, changes in hormone functioning, and developmental effects.[2] Immune system effects, including suppressed response to vaccines in children, have also been well documented.[19] A recent study found that among people infected with the coronavirus, those with elevated exposure to one specific PFAS were more likely to suffer a severe case of COVID-19.[20]

WHO IS AT RISK?

PFAS have contaminated the environment and food chains around the world, and all of us are exposed to some degree. However, some people are likely to have higher exposure, be more susceptible to the health effects of PFAS, or both. Groups who are likely to be highly exposed include workers in manufacturing plants that make or use PFAS, communities with contaminated drinking water, and firefighters.[17,18] Building construction and maintenance workers or do-it-yourselfers may also have elevated PFAS exposures. For example, tile and concrete spray-on waterproofing products containing PFAS have been implicated in several cases of acute pulmonary toxicity.[21,22] Susceptibility to the health effects of PFAS

Known health harms of PFAS have led state governments to set strict limits on the levels of PFAS allowable in drinking water.

is particularly high during prenatal and early life development. Given these risks, it is urgent that the building industry finds and adopts safer alternatives to the many products on the market that contain harmful PFAS.

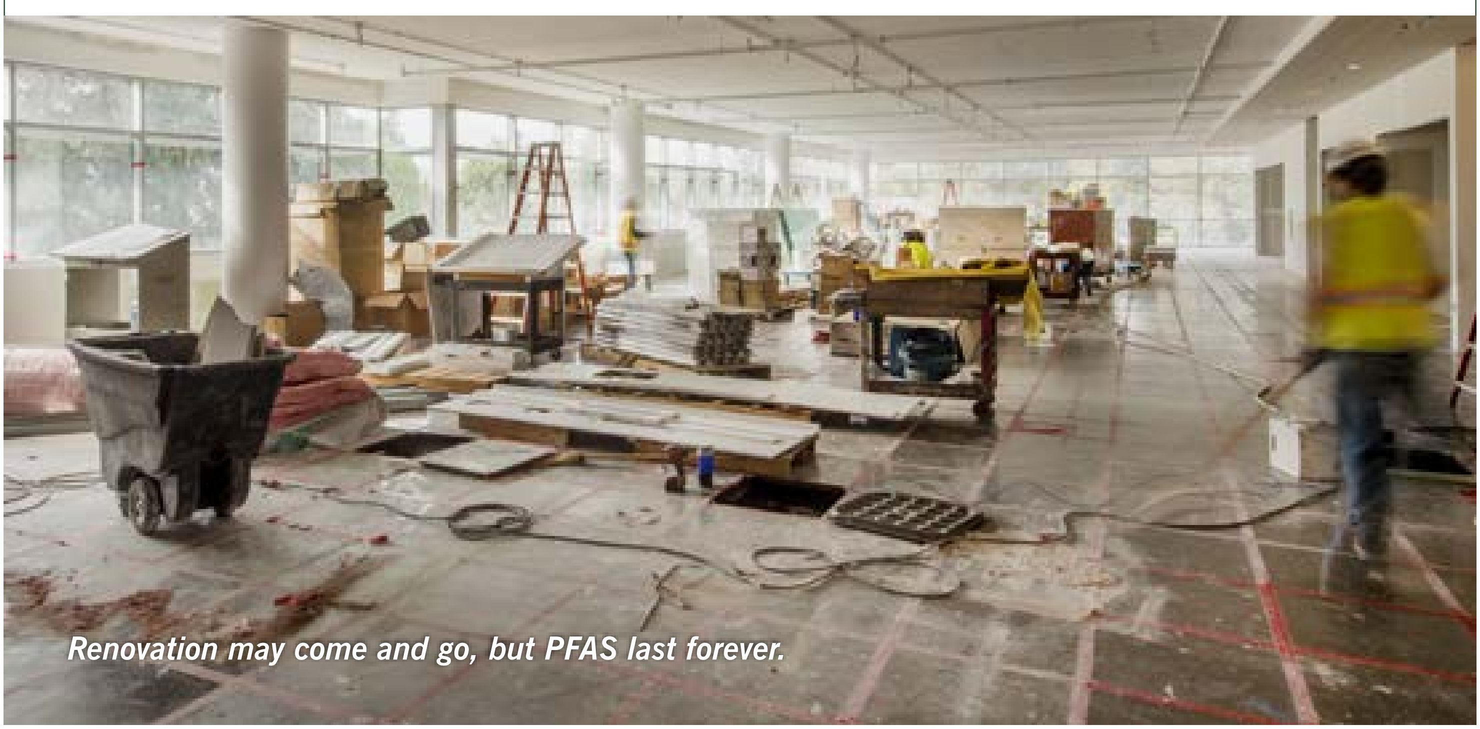
NON-ESSENTIAL USES

Federal, state, and local governments have begun working to reduce human exposure to PFAS and prevent health harm. Actions to date have focused on identifying contaminated water supplies and providing impacted communities with clean drinking water. Because complete remediation of PFAS contamination in the environment will be costly and time consuming—if even possible, efforts to prevent PFAS pollution should be prioritized.

One prevention approach that is gaining traction is identifying and phasing out non-essential uses of PFAS. This allows time for the development of safer alternatives for uses of PFAS that are currently deemed essential.[23] Hundreds of scientists have expressed support for this concept in the Madrid Statement published in 2015.[5] The "essential uses" approach is already being taken up by governments: Denmark, for instance, has banned PFAS in paper food packaging, and Washington was the first U.S. state to restrict the use of PFAS in firefighting foam.[24,25] The California Department of Toxic Substances Control is finalizing regulations to restrict PFAS in carpets and rugs[26] and San Francisco recently prohibited PFAS in city purchasing of carpet.[27] Other building materials have received less attention from regulators.

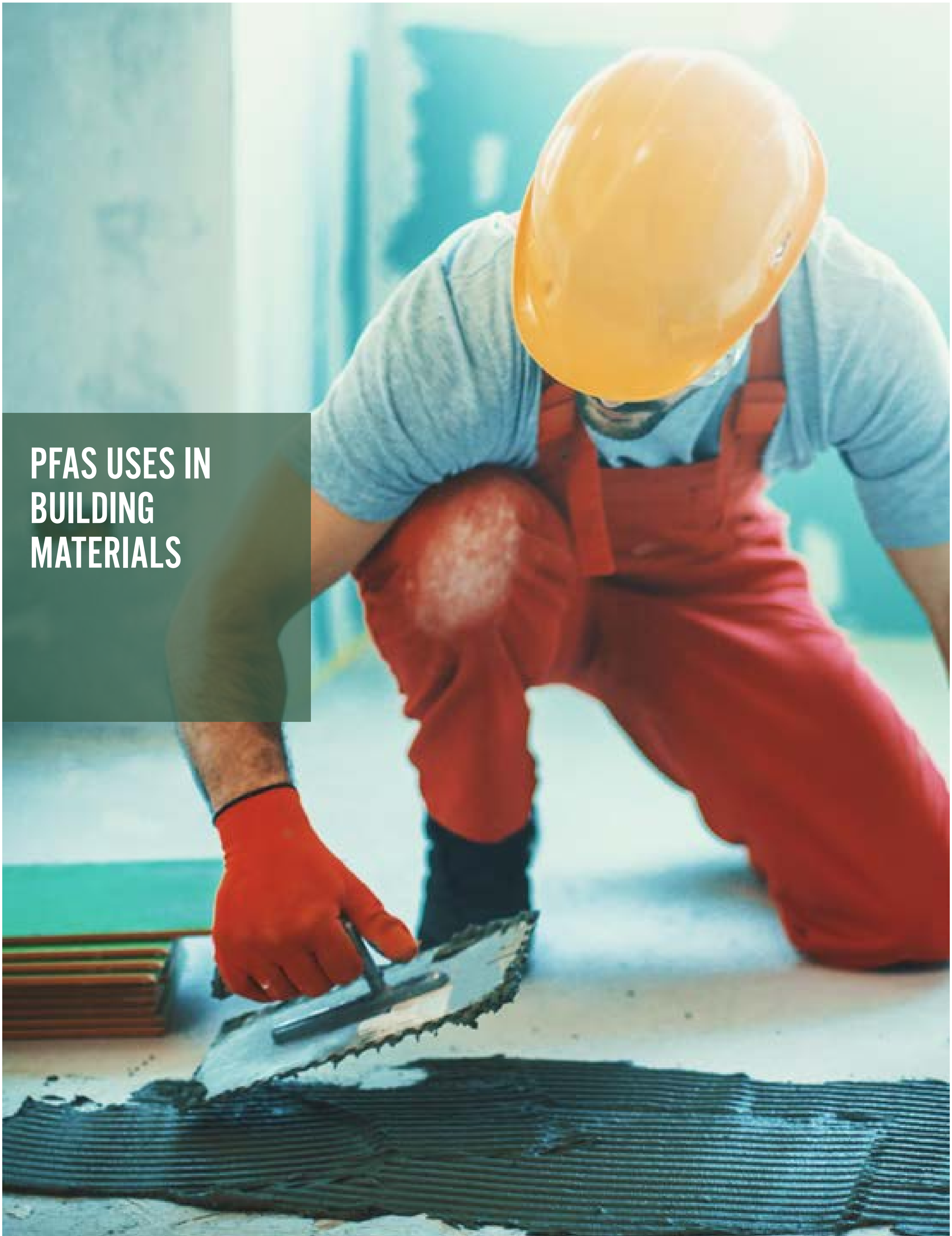
There is progress in the business world as well. Many consumer and retail companies are calling for a phaseout of all PFAS, and some, such as KEEN® Footwear, Levi Strauss & Co®, and COOP Denmark, have already or nearly achieved it. Numerous manufacturers are assessing their ability to identify and remove PFAS from their supply chains. Other organizations are striving to eliminate PFAS in the building materials and furnishings they purchase.

The goal of this report is to inspire a broader movement in the building industry to join the effort to eliminate unnecessary uses of PFAS and develop safer alternatives.



Renovation may come and go, but PFAS last forever.

PFAS USES IN BUILDING MATERIALS



The following sections provide information on the use of PFAS in different building product categories. We obtained information about PFAS and their use in building materials by searching peer-reviewed literature, government and non-governmental reports, patents, and company websites. This report does not cover all building products that contain PFAS, and within the categories below, PFAS may be more or less common.

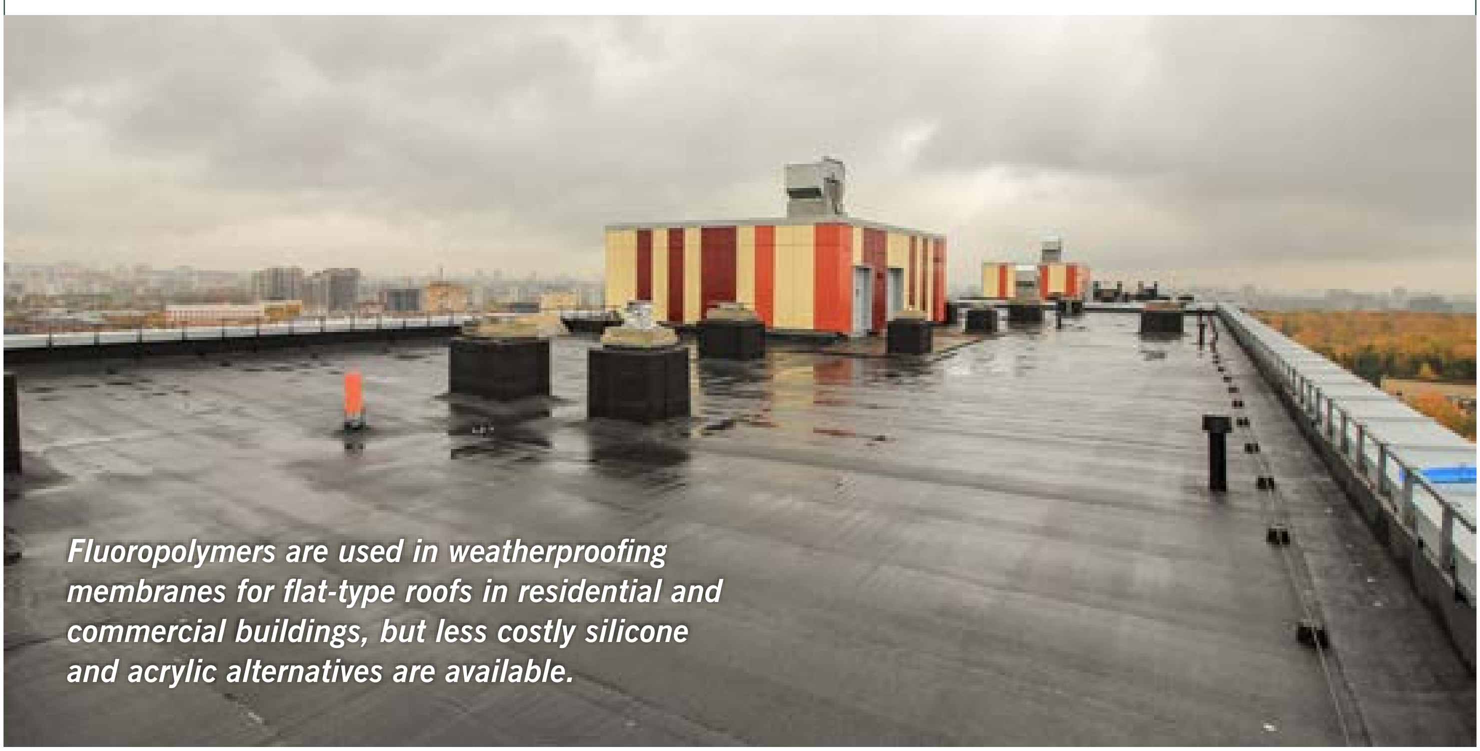
A note about alternatives: Throughout these sections, possible alternatives to fluorinated compounds are noted in italics. The materials mentioned are either readily identifiable as suitable alternatives, or listed as such in a report, research article, or patent. However, we cannot vouch for the relative efficacy of these possible alternatives. Also note that some of the materials listed as alternatives contain chemicals of concern other than PFAS. Analyzing the hazardous chemical content of non-PFAS alternatives was outside the scope of this report. Readers are encouraged to use due diligence to investigate the potential chemical hazards and the functionality of the PFAS-free building materials we identified.

ROOFING

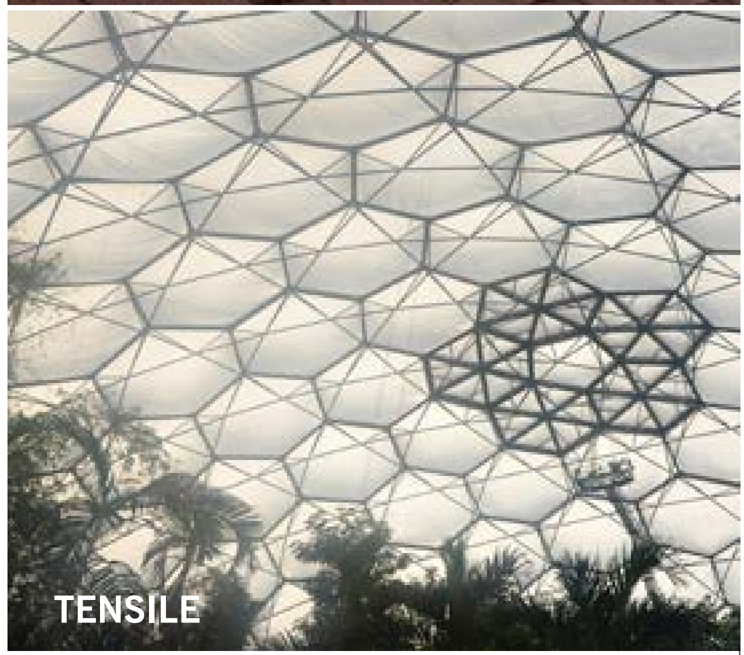
PFAS are used in four primary types of roofing materials: metal roofing, asphalt roofing, weatherproofing membranes for flat roofs, and textile-based roofs. A building's roof is in constant contact with the elements—UV radiation, temperature fluctuations, and precipitation can all limit a roof's lifespan. PFAS are used to resist weathering and prolong a roof's useful life while reflecting solar radiation away from the structure, keeping the interior cool.

Metal Roofing

PFAS are used as an exterior coating on metal sheet roofs, metal shingles, flashing, and roofing nails.[28-32] Fluoropolymer coatings protect metal from scratching, color loss, and corrosion and can be used to restore the aesthetic value of faded or deteriorated colored metal.[29,30] They may also serve to cool the structure by reflecting solar energy into the atmosphere and reducing the amount of heat entering the building.[28,29] Fluoropolymer coatings applied to metal roofing components are similar to those used in other types of building materials; all of these are discussed in further detail in the section on Coatings.



Fluoropolymers are used in weatherproofing membranes for flat-type roofs in residential and commercial buildings, but less costly silicone and acrylic alternatives are available.



PFAS-free alternatives such as silicone-modified polyester are commonly available and meet EPA's Energy Star certification standards for initial and maintained solar reflectance.[33-35]

Asphalt Roofing

PFAS may be used in asphalt-based roofing materials as a component of granules. Asphalt shingles and flat roofs commonly incorporate mineral-based granules to add aesthetic appeal, improve weather protection, increase UV-resistance and solar reflectivity, and to aid in ballasting.[28,36] Roofing granules consist of a core of rock or mineral covered by a pigmented ceramic coating.[28,36] Specialty granules designed for high solar reflectivity can employ coatings that contain PFAS.[37,38,*] Granules manufactured by 3M are coated with a proprietary surfactant polymer to prevent staining. It is unclear whether the coating contains PFAS.[39] In addition to granules, fluoropolymer coatings may also be applied to entire shingles.[40] *Titanium dioxide-based coatings are non-PFAS alternatives for increasing solar reflectivity.*[28,38]

*PFAS mentioned in patents for roofing granules include fluorinated polyurethane silane[37] and tridecafluoro-1,1,2,2-tetrahydrooctyl-triethoxysilane.[38]

Weatherproofing Membranes

Several fluoropolymers* may be used in weatherproofing membranes for flat-type roofs in residential and commercial buildings.[41] These membranes can be made of numerous materials, including synthetic rubber, polyvinyl chloride (PVC), polyolefin, or other heavy-duty thermoplastics, and sometimes contain a fluoropolymer layer or coating.[32,42,43] The fluoropolymers aid in moisture control and solar reflectivity, as well as conferring durability and stain resistance.[41] These membranes may also be clear or opaque for use in greenhouses.[9,44]

Heating of fluoropolymers like PTFE at high temperatures releases ultrafine particles that, when inhaled, can cause a health condition known as "polymer fume fever" and lead to severe acute lung injury.[45] Thus, installation of heat-welded roofing materials containing PFAS is a possible occupational exposure concern.

Silicone- and acrylic-coated membrane alternatives are available.[41,46]

Tensile Roofing

Fluoropolymers are used to create durable and decorative textile-based roofs. PTFE or ethylene tetrafluoroethylene (ETFE) can be applied as a coating on a rigid fiberglass base or woven into strands and then made into a textile-like material. So-called tensile roofs made of these materials are touted for their strength, durability, and low maintenance, and are often used for retractable and deployable structures such as stadiums, and for shade fabrics.[47-49] Notable examples of tensile roofs include the Beijing National Aquatics Center, the Minnesota Metrodome, and the Denver International Airport.[50-52] *Alternatives to textile roofing made with PFAS include silicone-coated*

fiberglass, PVC-coated polyester, and high-density polyethylene, at similar if not lower price points to ETFE and PTFE.[48,49] *PFAS-free alternatives reportedly have similar lifespans, fire ratings, maintenance requirements, and UV light filtering capabilities as fluorinated tensile roofs, but at a lower cost*.

Other Roofing Materials

Fluoropolymer coatings such as Dura Coat XT-10, Kynar 500, and Hylar 5000 are applied to rain gutters to repel dirt, resist staining and allow for easier cleaning.[53,54] *Alternative polyester-, silicone-, and acrylic-based coatings can provide similar weather protection without PFAS.*[55,56] *Gutters made from other metals such as galvanized steel have weather protective qualities and do not require coatings.*[57] *Non-chemical alternatives are also a good choice: using leaf guards and debris strainers, and increasing gutter slope decreases blockages and allows water to exit the system efficiently.*[58]

Liquid-applied fluoropolymer coatings have been proposed for concrete roofing tiles and wooden shingles to increase reflectivity, provide cooling, and resist dirt and mildew.[40,59] *Titanium dioxide-based coatings are a PFAS-free alternative for coating shingles.*[40]

*Patent literature indicates that numerous types of fluoropolymers may be used for weatherproofing membranes, including PTFE, ETFE copolymer, ECTFE copolymer, PCTFE, PVDF, copolymers of PVDF with acrylic resins, PVF, FEP, perfluoroalkoxy resin, copolymers of vinyl fluoride and vinyl ether, copolymers of FEVE with acrylic resins, and terpolymers of TFE, HFP and VDF.[41,42]

COATINGS

Coatings are broadly defined as exterior treatments that serve a functional purpose. PFAS are used to improve the performance of paints, metal coatings, and wood lacquers. They reportedly protect pigments, improve ease of application, increase weather resistance, and improve the finish and durability of these products. A recent study found over 100 distinct PFAS used in various paints, coatings, and finishes.[60] Data from the Nordic countries indicate that coatings and paints are the second highest use of PFAS by manufacturers in that region.[61]

Paints

Fluorinated additives (both polymeric and non-polymeric) can be used in epoxy-, oil-, alkyd-, and acrylic-based paints to achieve specific finishes and durability requirements.[62] PFAS lower the surface tension of paint, which allows for even flow, spread, and a glossy finish.[62,63] Polymer and non-polymer PFAS can be added to paints to provide non-stick, "graffiti-proof", dirt and stain resistant, oil- and water-repellent, and anti-corrosive properties.[63-68] Fluoro-modified polysiloxanes are added to paints as a deaerator to decrease bubbling.[31]

PFAS are also used in paints as binders.[31,62] Binders are polymeric materials that join the ingredients in the paint together, or help impregnate the substrate to decrease bubbling and peeling. Commercially available fluoropolymer binders include ZEFFLE® by Daikin Chemicals, and Lumiflon® by AGC Chemicals.[69-71]

PFAS are used in powder coating—a dry finishing process in which pigmented polymer powders are melted onto metal, wood or other surfaces.[72,73,*]. Fluorinated resins used in powder coatings, such as Solvay's

*Common fluoropolymers and copolymers used in powder coatings include FEVE, ECTFE, PVDF, perfluoro (alkylvinylether), tetrafluoroethylene perfluoromethylvinylether, ETFE, and FEP.[31,75]

HALAR® 6014,[74] reportedly result in higher weatherability, color and gloss retention, and resistance to chemicals, impacts, flames, and corrosion.[31,75,76]

Non-fluorinated chemicals commonly used as binders in both liquid paint and powder coats include acrylics, alkyds, and epoxies.[31,77,78] *Acrylic binders are known for their durability and gloss retention, while phenolic binders are best used in humid conditions. Hybrid materials such as phenolic-alkyd binders give paint the strength of the phenolics and the color retention of the alkyds.*[77] *PFAS-free alternatives for improving paint viscosity and spread include low aromatic mineral spirits and aromatic petroleum distillates.*[79] *Alternative deaerators in paints include polyacrylates, polyethers, and polysiloxanes.*[31]

Metal Coatings

Many metal coating formulations employ fluoropolymer binders to increase durability.[30,69,80] Fluorinated coatings are used as exterior finishes for large buildings, bridges, and industrial structures, in addition to high touch metal surfaces such as elevators and sanitary fixtures.[81] The addition of PFAS reportedly protects metal building products against weathering and staining and increases corrosion resistance.[71] PFAS-containing coatings are also used to increase the energy efficiency of metal roofs and exterior walls (by increasing reflectivity), to keep snow and ice from sticking to roofs and gutters, and even to aid in the penetration of coated roofing nails.[28,31] The use of PFAS coatings on metal structures may sometimes be required by building codes, as is the case for bridges in Japan.[82] Most PFAS-containing metal coatings are applied during manufacturing, but they can also be applied to building materials after installation as liquids or sprays.[30,83]

Polyvinylidene fluoride (PVDF) is the original and one of the most common fluorinated chemicals used in metal coatings,[80,84] but other polymeric PFAS are also used.* Brand name fluoropolymers used in metal coatings include Kynar® PVDF from Arkema, Hylar® PVDF from Solvay, Lumiflon® FEVE from AGC Chemicals, and ZEFFLE VDF/TFE copolymer from Daikin.[30,69]

* Fluoropolymer binders and additives reportedly used in metal coatings include PTFE, FEP, ETFE copolymer, PVF, PVDF, and FEVE.[30]

Metal entrances, doors, and door components (hinges, frames, latches, handles, locks, etc) may be coated with PFAS to enhance durability and thermal protection.[85-90] PTFE is used in door operators that help open and close doors in commercial buildings,[87,91] although the function is unclear.

Alternatives such as polyester and silicone-modified polyester are available at a lower cost point and are already used in coatings.[33,92] *Galvanization and anodization are effective and cost-efficient alternatives for some applications.*[92-95]

Wood Lacquers

PFAS are added to wood lacquers and sealers as wetting agents and to enhance oil and water repellency and stain resistance.[96-98] They may also be used in sealers to increase the dimensional stability of wood[99]* and as matting agents in factory applied finishes for wooden products including cabinetry.[100]

Patent literature indicates that paraffin waxes and silicones can replace PFAS in wood sealers for a similar water-repellent effect.[100] *Chemical treatments such as acetylation can increase dimensional stability and rot resistance.*[101-103] *Plastic-wood hybrids such as Trex® come with increased durability and have high recycled content (which may or may not contain PFAS or other chemicals of concern).*[104] *The use of naturally denser woods is an alternate way of limiting warping and rot when wood is exposed to moisture.*

Plastic Coatings

PFAS can be applied to plastic surfaces for a variety of applications. For instance, some dry erase boards utilize PFAS-containing coatings.** Fluoropolymer coatings can be applied on structural plastics that are used instead of glass or ceramic in items like windows, bathtubs, counters, shower stalls, and doors.[105,106,]***

*A patent indicates that perfluorinated hydrocarbons, fluorinated acrylic and methacrylic acid esters, fluoroalkanesulfonic acids, fluorinated carboxylic acids and their salts all may be used in wood sealers.[99]
**Erasable boards can contain fluorinated chemicals such as TFE, CTFE, VF, VDF, PTFE, ETFE, ECTFE, FEP, Korton-K 720, and Kynar 730.[107,108]

***Fluoropolymers reportedly used include PVDF, VDF, TFE, and HFP and their respective copolymers in addition to the monomers vinyl fluoride and trifluoroethylene.[106]

FLOORING

Carpets and Rugs

PFAS have been used extensively as stain, soil, and water repellents in carpets and rugs. Fluorinated chemicals reportedly prevent soiling and staining of the carpet fibers, protecting the carpet from discoloration and wear.[63,109] PFAS can be applied to carpets and rugs during the fiber manufacturing process, during the manufacturing of the carpets and rugs themselves, or as aftermarket treatments.[109]

In recent years most carpet manufacturers employed a type of PFAS called side-chain fluorinated polymers.[109] These polymers are attached to the carpet fibers, but they also contain non-polymer PFAS, including manufacturing residuals, impurities, and degradation products, that can migrate out of carpets and rugs.[109] Studies have linked carpeted floors to higher PFAS levels in indoor dust[110] and on interior surfaces.[111] Once PFAS is in dust, it can be inhaled and consumed by adults, children, and pets. Treated carpets and rugs may be a major source of PFAS exposure for young children, who have higher rates of hand-to-mouth contact and spend more time on the floor.[112]

MOST MAJOR CARPET MANUFACTURERS HAVE PHASED OUT PFAS IN FAVOR OF NON-FLUORINATED ALTERNATIVES. DEMAND FOR PFAS-FREE CARPETING FROM LARGE COMMERCIAL CUSTOMERS WAS A KEY DRIVER OF THIS SHIFT.

Aftermarket stain protectors and carpet cleaners can also contain PFAS. The original and most well-known fluorinated product is Scotchgard Carpet Protector.[113] These products are applied after the carpet has been manufactured, by professional carpet cleaners, custodians, or do-it-yourselfers. One study found that frequent use of an after-market stain protector in a home resulted in elevated levels of PFAS in carpet, dust, and the blood of residents.[114]

Major carpet manufacturers have begun to phase out their use of PFAS,[115-118] *and some major retailers are no longer selling PFAS-treated carpet.*[119,120] *Demand for PFAS-free carpeting from large commercial customers was a key driver of this shift. In lieu of fluorinated chemicals, manufacturers are adopting a variety of chemical and non-chemical alternatives. Potential chemical alternatives to PFAS include sulfonates, siloxane and silicone polymers, paraffins, polyurethanes, dendrimers, and acrylics.*[109,121] *Some of these alternatives are more durable than PFAS and can be reapplied less frequently. Many of these alternatives are polymers that coat the fibers without changing the texture or softness of the carpet. Non-chemical alternatives to PFAS include modification of the fiber shape and choosing fiber materials that are inherently stain resistant.*[109] *Durable non-fluorinated carpets are now readily available in a range of colors, textures, and patterns.*[122]

Resilient and Hard Flooring

PFAS are sometimes used to add stain and soil repellency to resilient flooring. In 2003 Mannington Mills advertised that its resilient flooring products would contain Teflon™.[123] More recently, flooring manufacturer Congoleum advertises the use of Scotchgard™ Protector[124] and a patent from Armstrong Flooring, Inc. mentions the use of various fluoropolymers in its stain-resistant coating.[100] Overall, PFAS appears to be used less frequently in the manufacturing of resilient flooring than in carpet.

A more widespread use of PFAS related to resilient and hard flooring is in after-market floor protectors, finishes, waxes, and polishes. By the early 1990s, fluorosurfactants had reportedly "been universally adopted in both household and institutional floor polish systems."[125] Fluorosurfactants continue to be used in these types of products as levelling and wetting agents.[126,127] Examples include Novec™ from 3M, Masurf® FS-120A from Mason Chemicals, and Capstone FS-65 from Chemours.[126,127] Fluoropolymers like PTFE are also sold to manufacturers of floor coatings and polishes as product additives.[128]

SEALANTS AND ADHESIVES

Fluorinated sealants are used to create a grease-resistant and water-resistant barrier that protects building materials from stains, mold, and physical damage. Grout, tile, and concrete sealers are applied to these materials to provide a clear, durable finish. Caulks are used to fill gaps and crevices, creating a waterproof seal. O-rings are used to create durable seals in plumbing applications. Adhesives, which are used to bond two materials together, sometimes contain PFAS to increase adhesion strength.

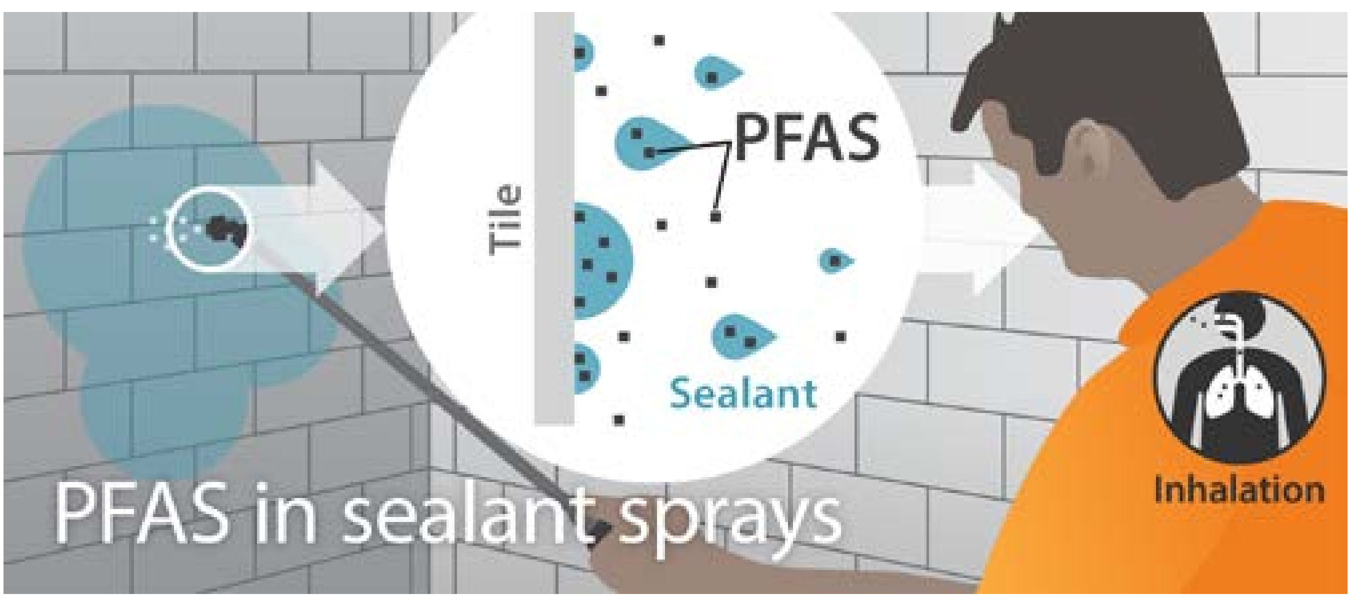
Grout, tile, stone, and concrete sealers

Porous materials such as stone, grout, unglazed tile, and concrete are often treated with a sealer or lacquer to create a smooth, water-resistant protective barrier. Sealers are used routinely in indoor applications including stone countertops, kitchen and bathroom tilework, and stone, tile, or concrete flooring. Sealers are also used in exterior applications including patios, staircases, foundations, and parking garages. PFAS are added to sealers to increase resistance to oil, water, stains, and (for exterior surfaces) snow, ice, and graffiti.[129-133,*] In the case of grout, PFAS-containing sealer is sometimes included as a component in the grout mix or paste.[134-136]

In 2005, dozens of cases of respiratory problems, dizziness, and disorientation were linked to Stand'n Seal Grout Sealer, a spray product sold in major home improvement stores.[137] It was later determined that the aerosolized fluoropolymer resins in the grout sealer were the likely cause of these health problems.[138] This led the U.S. Consumer Product Safety Commission to announce a voluntary recall of the product.[137] Due to the health hazards, legal troubles, and bad press, the sealer never returned to shelves.

Non-PFAS alternatives for sealing porous materials include silicones and epoxy, polyester, phenolic, urea, or furan resins.[139,140]

*Sealers for use on porous materials can include many different PFAS, such as resin-based fluorocarbons, PCTFE, perfluoroelastomer, perfluoroalkane sulfonic acids, fluorinated polyurethane dispersions, fluorinated acrylic polymers, fluoro-acrylate modified urethane emulsions, fluorinated acrylic polymers in ethyl acetate, and fluorochemical acrylic resin concentrate in ethyl acetate.[129,136]



Application of spray-on grout sealers can lead to inhalation of PFAS and cause acute health problems.

Caulks

Caulks are used to fill gaps and prevent the entry of water or other elements that may degrade a structure. PFAS are added to caulk formulations* to increase durability and chemical resistance while maintaining a strong bond between materials.[6,141,142] One patent also claims that the addition of PFAS reduces dust accumulation on the caulk.[143] Fluorinated caulks are used in the construction of building facings, elevators, and furniture.[144] *Caulks based on urethane, silicone, polysulfide, and acrylic chemistries are used in both do-it-yourself and commercial applications*[140,145] *and may be PFAS-free alternatives. Some caulks based on these other chemistries may also contain PFAS.*

O-Rings

O-rings used for high-pressure, high-stress, and high-temperature applications can be made of PFAS. Fluoroelastomer O-rings (such as Viton®) are available for sanitary washers, fittings for medium to large PVC pipe**, and potable water appurtenances such as water heaters and hose bibs.[146-148] Some of these products may also contain Teflon-coated washers.[149] While O-rings are a common component of plumbing systems, it is unclear how often high-performance PFAS-containing O-rings are used in residential and commercial structures. *O-rings made of non-fluorinated elastomers such as polyacrylate and nitrile can be used instead of PFAS.*[150,151] *Reported disadvantages of fluoroelastomer O-rings include that they require extremely high pressure to form a proper seal and that they are rigid, which makes them difficult to reuse.*[150]

*Caulk formulations can reportedly contain VDF; terpolymers of HFP, VDF, and TFE;[142] and the following PFAS functional groups: polyfluoropolyether silane; 3,3,3-trifluoropropyl; fluoromethyl; 2-fluoropropyl; 3,3,3-trifluoropropyl; 4,4,4-trifluorobutyl; 4,4,4,3,3,-pentafluorobutyl; 5,5,5,4,4,3-heptafluoropentyl; 6,6,6,5,5,4,4,3,3,-nonafluorohexyle; and 8,8,8,7,7-pentafluorooctyl.[143]

**Schedule 80 and above.

Adhesives

Adhesives are used in many applications in building construction, including adhering tiles, flooring, drywall, ceiling, wood-related materials and molded structures. PFAS are added to adhesives to increase the strength of the bond adhering materials together. There are two mechanisms for this increased adhesion. One is that PFAS enhance the penetration of adhesives into their substrates. Another is that they increase the adhesive's wettability, allowing for greater spread and increased contact area between the adhesive and adhered materials.[60,63,140] Examples of PFAS advertised for use in adhesives include Capstone FS-30 and FS-31.[152] Limited evidence from a patent suggests that fluorocarbon-based synthetic rubbers, known as fluoroelastomers, may be used in adhesives as well.[153] *Many adhesive formulations are made from non-fluorinated chemicals.*[140]

GLASS

Fluorinated chemicals are used in a variety of glass building materials such as windows, doors, and mirrors.* PFAS increase the durability of glass and limit the buildup of dust and debris on glass surfaces.[154,155] This makes PFAS-treated glass useful in hard-to-access locations, such as building facades and solar panels on roofs. PFAS are often applied to glass surfaces as coatings, but in some instances the PFAS can comprise a separate layer within the glass panel.[156]

Windows, Doors, and Other Glass & Ceramic Fixtures

Common building materials such as windows, mirrors, shower doors, bathtubs and toilets may be treated with PFAS. Fluorinated coatings are used to make glass and ceramic surfaces more durable and resistant to heat and abrasion, to prevent soiling and

grime, and to provide 'easy to clean' and anti-smudge characteristics.[81,154,155,157] Examples of PFAS advertised for use as glass and ceramic coatings include SURECO™ 2320[81] and the Easy Clean Coatings series.[154,157] Fluoropolymer-glass composites have also been patented for use in fire-resistant applications.[156]

Most PFAS-containing glass treatments appear to be marketed to product manufacturers rather than do-it-yourselfers (DIY). It is not clear whether products for the DIY market contain PFAS.[158] *Researchers have developed fluorine-free "omniphobic" polyurethane and polydimethylsiloxane glass coatings that repel oil and water and are also self-healing and resistant to chemical wear.*[159-161] *These materials may be suitable alternatives to PFAS for glass and ceramic coatings, but it is not clear if they are commercially available.*

Lightbulbs

Fluoropolymer coatings are applied to "shatterproof" light bulbs advertised for laboratory, medical, and consumer uses.[162,163] PTFE coatings reportedly increase the durability of the bulbs and impart non-stick and easy-clean characteristics without changing the color, temperature, or shading of the light.[163,164] Fluoropolymers are also used in electroluminescent lamps such as safety exit signs in commercial build-

*A patent from Arkema states that glass coatings can contain PTFE, PVF, PCTFE, FEVE, and copolymers made from the following monomers: VDF, TFE, trifluoroethylene, chlorotrifluoroethylene, HFP, vinyl fluoride, perfluorobutylethylene, pentafluoropropene, 3,3,3-trifluoro-1-propene, 2-trifluoromethyl-3,3,3-trifluoropropene, fluorinated vinyl ethers, fluorinated allyl ethers, non-fluorinated allyl ethers, and fluorinated dioxoles.[155]

ings.[9,60,*] PFAS coatings on light bulbs have been known to cause respiratory distress and death in birds, including poultry.[165]

Alternatives to PFAS-containing shatterproof light bulbs include using LED or other light sources that do not require glass enclosures.

FABRICS

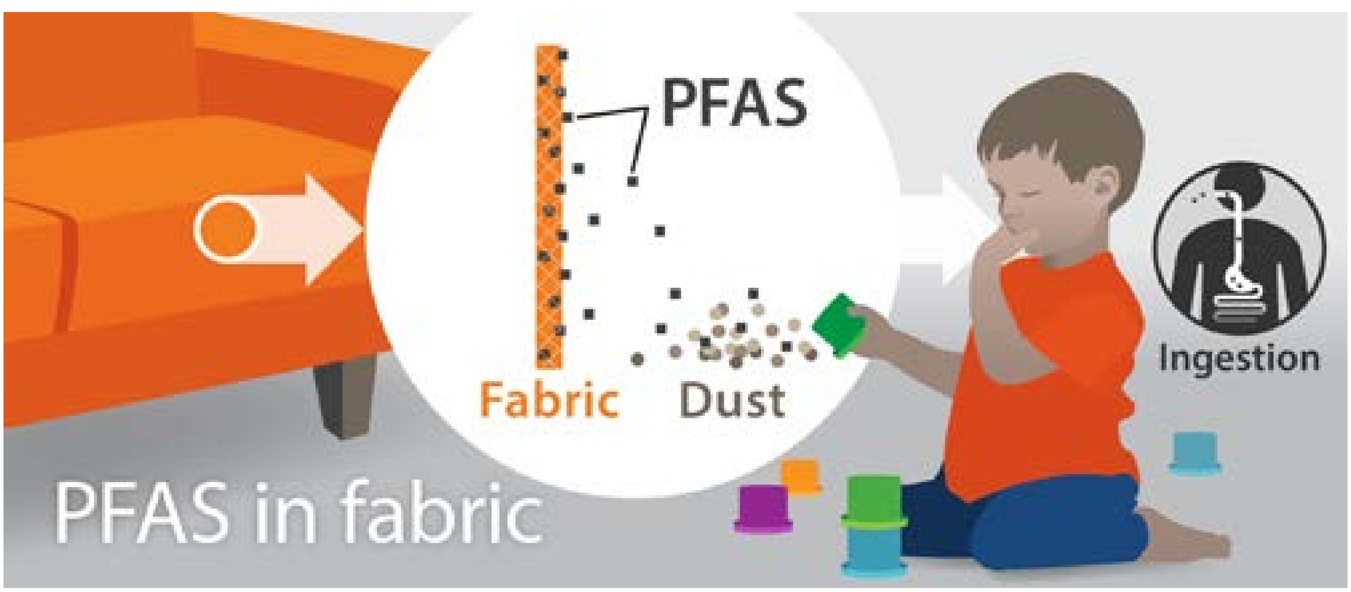
PFAS are added to fabrics used in furniture, curtains, etc., for their stain-, soil-, and water-repellent properties.[166] Fluorinated treatments can be applied to individual fibers or finished fabrics during manufacturing, or after-sale in the form of sprays. Several brand name PFAS-containing treatments include Teflon®, Nanosphere®, Scotchgard®, Capstone®, Crypton®, Crypton® Green, Nanotex®, Nanotex® + Durablock®, and GreenShield®.[167]

Furniture brands such as HermanMiller and IKEA have successfully phased out PFAS in their merchandise.[168,169] A variety of chemical alternatives to PFAS are available for use in fabrics. Water- and urethane-based products include Teflon EcoElite™ and DetraPel®.[170-172] Alternative paraffin or silicone-based polymeric finishes include Aquapel™, Crypton® Zero, NikWax®, Zelan™ R3, EcoRepel®, Altopel F3, Arkophob®, Arroshield EVO, SBI, and Phobotex® WS.[167] Other alternatives include nanosilica that coats individual fibers, creating a rough surface to which water and oils cannot adhere.[173] To avoid additional chemicals, textiles that have tighter weaves and are naturally more resistant to water and oil can be used. Olefin-based fibers (polypropylene) can be used to create durable fabrics[174] and are widely available from major retailers like Crate&Barrel, Bassett, Room&Board, and City Furniture.[175]

Wall and window coverings can also be made with PFAS,[176-178] such as Dupont's Tedlar Wallcoverings, which the company recommends for high traffic areas.[177]

Fabric awnings used in front of commercial and residential spaces may be treated with PFAS for water- and stain-proofing. Four of five acrylic awnings measured in a German study contained fluorotelomer alcohols and perfluorocarboxylates at levels that indicate the use of side-chain fluoropolymers.[179]

*Fluoropolymers used in lighting include PCTFE and a three component polymer, TFE/HFP/VDF.[9]



Treated fabrics are a likely source of PFAS in indoor dust, which can lead to ingestion of PFAS.

WIRES AND CABLES

Electrical wires and cables (groups of wires) are typically insulated with a non-conductive plastic sheath, often made of PFAS. The insulating properties of fluoropolymers allow for the use of thinner insulating sheaths that are flexible, durable, and stand up to high temperatures.[180] This makes them useful for applications such as air conditioner units, computers, light fixtures, and radiant heated flooring.[181,184] The NFPA 70 (Electrical Code) lists PTFE and ETFE as suitable for insulated wiring for all purposes, and ethylene chlorotrifluoroethylene (ECTFE), perfluoro-alkoxy, PTFE, and ETFE as suitable for building fixtures.[185] Several large chemical manufacturers sell PFAS-containing formulations for coating wires, including Tefzel from Chemours and Halar from Solvay.* PFAS are also used in electrical tapes in air ducts, which are covered in the 'Tape' section.

Alternatives to PFAS-containing wire sheaths include silicone, chlorosulfonated polyethylene, PVC, polyethylene, cross-linked polyethylene, chlorinated polyethylene, ethylene vinyl acetate, thermoplastic elastomer, neoprene, ethylene-propylene rubber, and nylon.[180,186] *Many of these alternatives can function at high temperatures while also being resistant to corrosion. These alternatives are also more cost-effective since PTFE can cost 8-10 times more per pound than PVC.*[180]

*The Asahi Glass Company and Daikin both hold several patents for PFAS-containing insulated wires that call for copolymers of TFE/propylene, ethylene/TFE, TFE/HFP, and ethylene copolymer along with an epoxy and flame retardant.[198-200] Chemours has developed an ETFE trademark under the name Tefzel, specifically formulated to be used in wiring.[201] Other PFAS used in wiring include PVDF (Solef/Kynar), ECTFE (Halar), perfluoroalkoxy and FEP (Teflon).[180,186,202,203]

TAPE

PFAS-containing tape is used in electrical work, plumbing, sealing, and many other applications. One of the most well known uses of PFAS in building projects is Teflon plumber's tape, also known as thread-seal tape, which is used to seal pipe connections and other threaded fittings.[140,187] It works by filling the spaces between interlocking pipe threads to create a seal and prevent leaking. Plumber's tape is made of 100% PTFE film, which reduces friction and prevents rust.[188,189] Liquid/paste pipe thread sealant can also contain PTFE.[190]

PTFE tape can contain residual amounts of non-polymer PFAS that have the potential to leach into drinking water. PFOA, for instance, has been used to manufacture PTFE and has also been detected in PTFE tape.[191,192] PTFE tape is normally in contact only with pipe threads and not with flowing water. However, if installed incorrectly it can tear and enter the interior of a pipe system where the potential for leaching is greater.[140]

Silicone-based thread-seal tapes are available but less common.[193,194] *Liquid/paste pipe thread sealants without PFAS are available.*[195,196] *Such products can be stronger and more durable alternatives to PTFE tape and are thus preferred by plumbers for permanent seals.*[197]

Fluorinated fiberglass and film tapes are used in electrical applications in drop ceilings and other open-air spaces, for example, to wrap bundles of wires that run between separate floors of commercial buildings.[204] These tapes are composed of a PTFE-impregnated plastic or a fiberglass base with an adhesive layer.[204-206] PTFE or other fluoropolymers serve as an insulator and strengthening agent and help prevent abrasion.[207]* These taped bundles can be surrounded by a layer of PVDF, which, in addition to the PTFE in the wire sheath, acts as a flame retardant and protectant from corrosion and water damage.[204] Fluorinated tape is also used inside conduits so that bundles of wires can be easily removed or inserted.[206]

PTFE tape is used in the manufacturing and installation of windows, doors, vents, skylights and other structural openings. During manufacturing, fluorinated tape is employed to hold PVC frames together and prevent physical deformities during welding.[208,209] Some windows and skylights may still have this tape holding the frame together up until installation or be installed into the structure with the tape. Flashing tape used to seal the frame of a door, window, or other opening to the wooden frame of a building may also contain PFAS.[210,211]

It is unclear how often PFAS is used in flashing tape, but this type of tape can be made from numerous non-PFAS materials, including ethylene vinyl acetate, high density polyethylene, polyester, and polyurethane.[211] *The fluorinated tapes used to protect PVC frames during welding may be unnecessary.*

PFAS-containing tape can also be used in flooring applications to adhere carpet and resilient flooring to the underlay or subfloor.[212,213] Fluoropolymers are used in the release liners (covers that protect adhesive tape before application) and are thrown away after use.

* A Daikin Industries patent cites the following fluorine-containing resins for use in tapes: PTFE, TFE/perfluoro(alkyl vinyl ether) copolymer, TFE/HFP oxide copolymer, ethylene/TFE copolymer, and PCTFE.[206]

TIMBER-DERIVED PRODUCTS

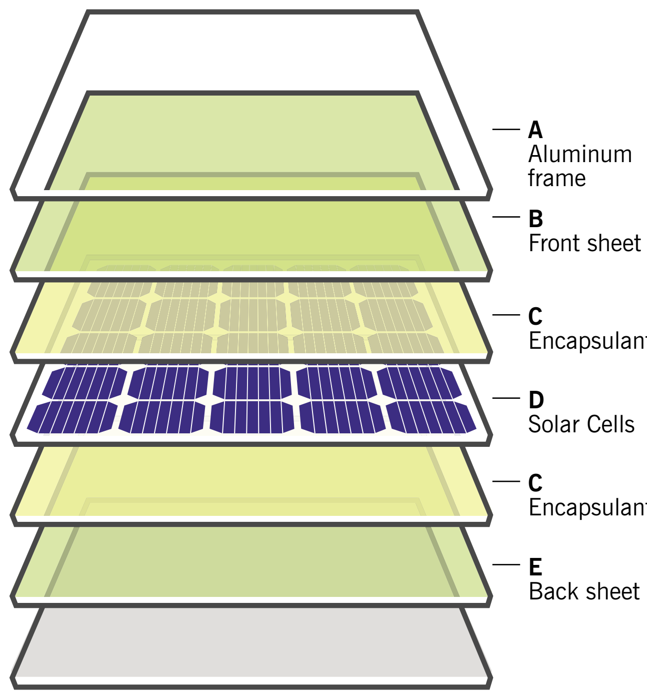
Evidence suggests that PFAS may be used in composite wooden sheets like oriented strand boards (OSB), medium and high-density fiberboard (MDF and HDF), and plywood. A study of European building products detected small amounts of PFOA and other PFAS in 14 samples of OSB and other composite wood materials.[214] The source of the PFAS may have been adhesives used during manufacturing.[179,214] A separate study reported that adding PFAS to a urea-formaldehyde resin used in particleboard improved the properties of the board.[215]

The same study that detected PFAS in composite wood sheets found similar levels in two samples of wood fiber insulation, which is marketed as an eco-friendly alternative.[216] PFAS levels in both the wood sheets and wood fiber insulation were relatively low and could have resulted from unintentional background contamination.

SOLAR PANELS

Numerous uses of PFAS are documented in solar panels.[9,217,218] Fluoropolymer coatings or films may be incorporated into the glass top layer of panels, the encapsulant film that surrounds the solar cells, and the backsheet.[219-221] Fluoropolymers reportedly increase durability, transparency, UV-resistance, heat-resistance, mechanical strength, dirt-repellency and energy production, and they are lightweight.[220-223] Halar® (ECTFE) and Tefzel® (ETFE), as well as polyvinyl fluoride (PVF) and PVDF, are among the fluoropolymers used for solar panels.[9,218]

Rechargeable batteries that are increasingly used to store the energy captured by solar panels also contain PFAS. Reported uses of fluoropolymers in lithium-ion batteries and supercapacitors include enhancing chemical resistance and adhesion properties and strengthening the ionic conductivity.[218,219,*]



Deconstructed solar panel

These PFAS may be found in each component:

A (Aluminum frame): FEVE and other proprietary fluoropolymers[224,225]

B (Front sheet): ETFE, ECTFE, FEP[218,226]

C (Encapsulant): PVDF, ETFE[220,221]

E (Back sheet): PVF, PVDF, ECTFE, ZEFFLE, a polymer of TFE, HFP, and VDF[218,222,227]

* In both types of batteries NEOFLON ® PVDF, NEOFLON VT (a tetrafluoroethylene and vinylidene fluoride copolymer), NEOFLON perfluoroalkoxy alkanes, PVDF, and PTFE are used.[218,219]

ARTIFICIAL TURF

Artificial or synthetic turf is used as a water- and maintenance-saving alternative to live grass landscaping. Its popularity is growing, and as of 2015 there were 11,000 artificial turf fields in the U.S. and 13,000 in Europe.[228] Synthetic turf is made up of artificial fibers resembling blades of grass that are woven into a backing material. The grass-like fibers are generally made from nylon, polypropylene, or polyethylene. Granular material, known as infill, is often used to fill in space between the blades and stabilize the turf surface.[229]

Recent reporting indicates that both the backing and the blades of artificial turf can contain PFAS.[230] One study reported measurable levels of total fluorine in blades from eight samples of artificial turf, suggesting that PFAS may be used as polymer processing aids during manufacture of the blades.[231] Fluoroelastomer- or fluoropolymer-based processing aides can be added to melted plastic during extrusion to keep the equipment operating smoothly and prevent defects in the finished plastic pieces.[232] Such processing aids would still be present in the final turf blades or backing. The same study detected very low levels of non-polymer PFASs in two samples of artificial turf backing, 1,000 to 1,000,000 times lower than concentrations reported in fibers from new carpet.[233,234] *Cost-effective alternatives to fluorinated processing aides include thermoplastic polyurethane-based elastomers.*[235]

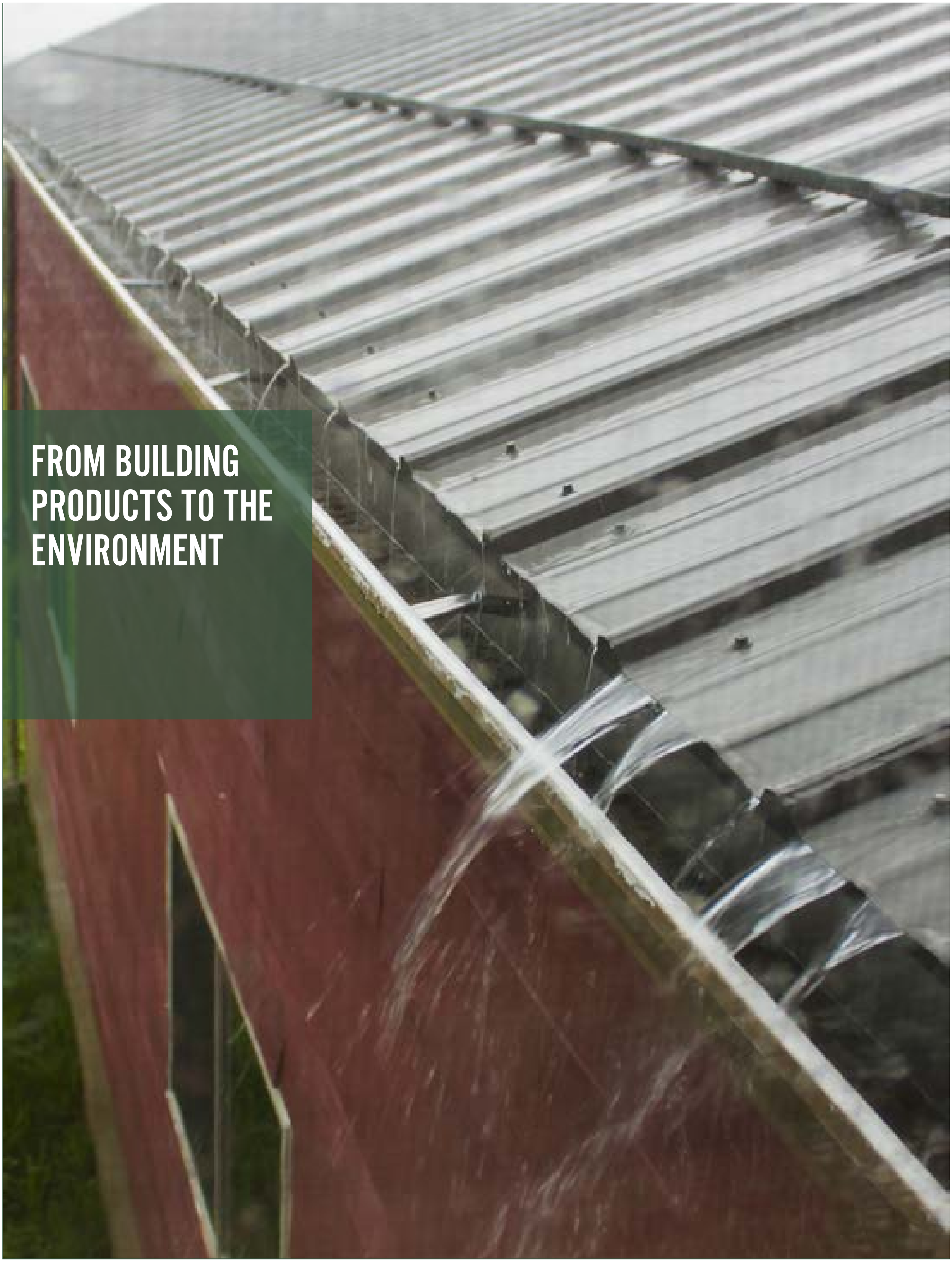
Artificial turf infill is often made from recycled tires, which may be another source of PFAS.* Polymeric pellets manufactured specifically as infill are also available, and patents indicate that these materials may contain PFAS as well.[236,237] The infill associated with artificial turf can cling to textiles such as shoes, clothes, and athletic equipment, leading to human exposure on the field, in the car, and at home. Data on PFAS concentrations in artificial turf are scarce, so it is difficult to know the magnitude of this potential exposure pathway.

SEISMIC DAMPING SYSTEMS

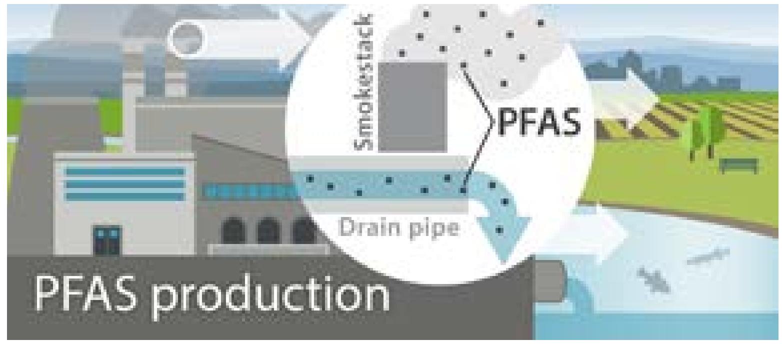
PFAS are employed in seismic dampers used to make large buildings and bridges resilient to earthquakes. PTFE pads or discs are used in a variety of ways within structural skeletons and foundations to allow structures to remain standing.[238-246] In some cases, PTFE bearings are required by California state law in bridge construction.[246]

* The following fluorinated chemicals may be used in tire manufacturing and may be present in recycled tires: tetrafluoroethylene-perfluoro methylvinylether copolymer, tetrafluoroethylene-perfluoro ethyl vinyl ether copolymer, PTFE, FEP, ETFE, PVDF, PCTFE, and PVF.[252-254]

FROM BUILDING PRODUCTS TO THE ENVIRONMENT



There are several ways in which building materials can be a source of PFAS releases to the environment. The first takes place before a building is even constructed, during the production of PFAS and the manufacture of products. Facilities that produce PFAS (including fluoropolymers) and manufacturers who use PFAS to make other products are sources of serious contamination in communities worldwide.[7,18,247,248] Demand for PFAS-containing building products has contributed indirectly to the contamination of air, water, land, and food chains in these locations.

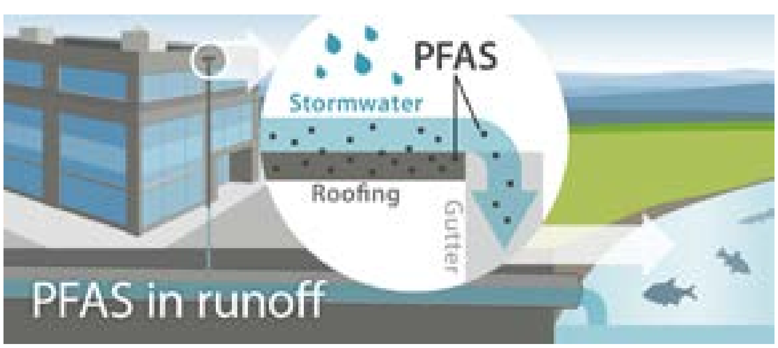


Factories that produce and use PFAS are major sources of PFAS pollution.

PFAS can also be released from building products while the products are in use. For instance, interior furnishings can release PFAS into indoor dust. A recent study found that renovating buildings with PFAS-free furniture reduced PFAS levels in dust by 78%.[249]

Wash water used to clean flooring and textiles may carry PFAS from floor and textile treatment products into sewer systems and the aquatic environment. For instance, disposal of floor wash water into septic systems is thought to have contaminated drinking water at two schools in Vermont.[250]

Another likely source of pollution is rain and snow that falls on roofing, awnings, painted or coated surfaces, artificial turf, etc. PFAS may leach from building materials into precipitation, or PFAS-containing materials (e.g. roofing granules) may detach and be transported in runoff. Either scenario would result in PFAS washing off of buildings and onto land or into sewer systems and waterways. Researchers have detected PFAS in stormwater[251] but further research is needed to confirm if, and to what extent, building materials contribute to PFAS in runoff.



Stormwater runoff that contacts PFAS-containing surfaces is a possible source of PFAS releases to the environment.

End of life disposal of building materials may also lead to environmental emissions of PFAS. Large amounts of waste building materials are disposed of in municipal solid waste and construction and demolition landfills, and leachate from both types of landfills contains PFAS.[255] PFAS-containing building products may also be sent to municipal solid waste incinerators, which have the potential to release PFAS emissions into air.

Recycling of building materials is another potential source of emissions. For example, ten million tons of used asphalt shingles are removed from roofs annually in the U.S.[256,257] These shingles are typically sent to landfills, but are sometimes recycled into asphalt pavement.[258,259] PFAS emissions could occur during the recycling process or once the pavement is installed. Carpets and artificial turf are also high-volume waste streams that have the potential to transfer PFAS into new products if they are recycled.

MOVING FORWARD

MANAGING PFAS AS A CLASS

PFAS came into the public eye in the early 2000s when a class-action lawsuit revealed extensive contamination of drinking water around a PFAS manufacturing site near Parkersburg, West Virginia.[2] As a result of this and other incidents, fluorochemical manufacturers in the U.S. agreed to voluntarily phase out PFOA and related harmful chemicals. Those chemicals were then replaced by substitute PFAS purported to be less toxic, and to pass through the body more quickly. Unfortunately, a growing body of research shows that not only are the substitutes harmful, but they are also already found in the bodies of many people in the U.S. and elsewhere. This is an example of a phenomenon known as "regrettable substitution".

SCIENTISTS AND NGOs ARE CALLING FOR GOVERNMENTS AND BUSINESSES TO MANAGE PFAS USING APPROACHES THAT ADDRESS THE ENTIRE CLASS OF CHEMICALS.

Current government estimates put the number of distinct PFAS at greater than 9,000, a figure that keeps growing as more are being identified.[260] Studying the possible health hazards of each of these thousands of chemicals is not practical. Instead, scientists and non-governmental organizations are calling for governments and businesses to manage PFAS using approaches that address the entire class of chemicals.[261] Instead of switching from PFAS that are known to be harmful to other PFAS for which environmental and health data are scarce, manufacturers and purchasers can often choose to avoid the class of PFAS altogether.

While chemical producers have agreed that certain PFAS should be phased out, they and some product manufacturers oppose the comprehensive approach of avoiding the entire class.

One contentious question is whether fluoropolymers belong in the class of PFAS. The argument for excluding fluoropolymers from the class is based on the assertion that they are biologically inert because of their high molecular weight.[262] Emerging evidence shows that fluoropolymers are a diverse group of substances and that the assumptions that they are inherently non-toxic may be too simplistic.[7] However, the larger issue is that fluoropolymers can be a source of harmful PFAS emissions throughout their lifecycle (manufacturing, use, and disposal/recycling). As examples, fluoropolymer manufacturing has caused extensive environmental contamination; end-of-life incineration of fluoropolymer-containing products can be a source of hazardous air emissions; and fluoropolymer microplastics are a pollution problem worldwide.[263,264]

THE NEED FOR TRANSPARENCY

The first step in reducing the use of PFAS is knowing the ingredients in building products. Fortunately, the building industry has made great strides in recent years in its use of material ingredient data, and transparency is becoming the new norm. Architects, designers, and other specifiers increasingly request this type of information from building product manufacturers, and manufacturers increasingly make it available. Tools like Health Product Declarations and Declare Labels and platforms like Pharos and Matter

have been developed to make this exchange of information simpler (see Appendix A for a list of Declare labels and Health Product Declarations that disclose the use of PFAS in a building product). Owners, architects, and designers should support expanding the content disclosure movement to more manufacturers and more product types.

SAFER ALTERNATIVES TO PFAS EXIST, AND MORE CAN BE DEVELOPED. THE BUILDING INDUSTRY HAS THE ECONOMIC POWER AND THE TECHNICAL EXPERTISE TO MOVE THE MARKET AWAY FROM PFAS.

SAFER ALTERNATIVES

Increased transparency makes it easier for builders to choose healthier alternative materials without PFAS. In some cases these materials are already available in the marketplace. In other cases, demand for PFAS-free alternatives will send a signal to manufacturers that new solutions are needed. Product manufacturers considering replacement chemicals should assess them with an eye towards preventing regrettable substitution, and should consider non-chemical solutions when possible. Programs such as ChemFORWARD and Green Screen for Safer Chemicals® can help manufacturers and builders in making these decisions.[265,266] In addition, governments can use their high volume purchasing and specifying power to eliminate non-essential PFAS, thus incentivizing the development of safer alternatives.

The urgency of this issue cannot be overstated. Nearly every person tested has PFAS in their blood, even newborn babies. Because the chemicals are so persistent, current levels will only increase if society continues adding more PFAS to our environment.

WHAT CAN YOU DO?

Working toward the use of safer chemicals in building materials is an ongoing process that starts with a commitment to raising the standard of care. Several stakeholder groups have a role to play.

Remember that change doesn't happen overnight, but progress can be made quickly. Be proud of your achievements, measure them, and report them widely.

ARCHITECTS, DESIGNERS, AND BUILDERS

Product specifiers have a tremendous amount of power to create a healthier built environment.

- Educate yourself and your colleagues about harmful chemicals in the products you use. The short videos at **SixClasses.org** are a helpful place to start.
- Request ingredient disclosure from product manufacturers. Standardized disclosure tools like HPDs and Declare labels make this easier.
- Ask "Is it necessary, given the potential for harm?" Eliminating non-essential uses of PFAS (those that do not add a critical function) can readily reduce your project's chemical footprint.
- Ask for independent research demonstrating the effectiveness of PFAS for their intended function.
- Identify safer alternatives to PFAS for uses that are necessary.
- Innovate design details which eliminate the need for PFAS.

BUILDING PRODUCT MANUFACTURERS

Product manufacturers play a key role in moving towards safer chemistries.

- Request transparency from chemical suppliers.
- Provide ingredient disclosure to your customers.
- Standardized disclosure tools like HPDs and Declare labels make this easier.
- Work to phase out PFAS from your product lines by substituting PFAS-free alternatives or through design changes.
- Ask your suppliers to develop safer alternatives without PFAS. If your customers are asking for PFAS-free products, shifting that demand upstream to your chemical suppliers can transform the industry.

GOVERNMENTS

Government agencies have influence not only through regulation, but also through purchasing agreements.

- Restrict PFAS-containing products that are not essential. Cities, states, and even countries have already taken this step for products like food packaging and firefighting foam.
- Use your purchasing power to require manufacturers to disclose chemical ingredients and to eliminate non-essential PFAS.
- Require manufacturers to disclose which PFAS they are using and where.

LIST OF REFERENCES

1 Agency for Toxic Substances & Disease Registry. (2018). ATSDR - *Toxicological Profile: Perfluoroalkyls*. Agency for Toxic Substances & Disease Registry. https://www.atsdr.cdc.gov/ToxProfiles/tp200.pdf. Link.

2 C8 Science Panel. (2012). *C8 Probable Link Reports.* C8 Science Panel. http://www.c8sciencepanel.org/prob_link.html. Link.

3 National Toxicology Program. (2016). *NTP Monograph Immunotoxicity Associated with Exposure to Perfluorooctanoic Acid or Perfluorooctane Sulfonate.* In the National Toxicology Program. https://ntp.niehs.nih.gov/ntp/ohat/pfoa_pfos/pfoa_pfosmonograph_508.pdf. Link.

4 Gomis, M. I., Vestergren, R., Borg, D., & Cousins, I. T. (2018). Comparing the toxic potency in vivo of long chain perfluoroalkyl acids and fluorinated alternatives. *Environment International*, 113, 1–9. https://doi.org/10.1016/j.envint.2018.01.011. Link.

5 Blum, A., Balan, S. A., Scheringer, M., Trier, X., Goldenman, G., Cousins, I. T., Diamond, M., Fletcher, T., Higgins, C., & Lindeman, A. E. (2015). The Madrid statement on poly and perfluoroalkyl substances (PFASs). *Environmental Health Perspectives*, 123(5), A107–A111. https://doi.org /10.1289/ehp.1509934. Link.

6 FluoroCouncil. (2019). *Fluorotechnology for buildings and construction applications*. FluoroCouncil. Retrieved March 20, 2020, from http://businessdocbox.com/107328049-Green_Solutions/Fluorotechnology-critical-to-modern-life.html. Link.

7 Lohmann, R., Cousins, I. T., DeWitt, J. C., Glüge J., Goldenman, G., Herzke, D., Lindstrom, A. B., Miller, M. F., Ng, C. A., & Patton, S. (2020). Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology*, 54(20), 12820–12828. https://doi.org/10.1021/acs.est.0c03244. Link.

8 Altman, R. (2019). *Time-bombing the future*. Aeon; https://aeon.co/essays/how-20th-century-synthetics-altered-the-very-fabric-of-us-all. Link.

9 Gardiner, J. (2015). Fluoropolymers: origin, production, and industrial and commercial applications. *Australian Journal of Chemistry*, 68(1), 13–22. https://doi.org/10.1071/CH14165. Link.

10 Danish Environmental Protection Agency. (2018). *Risk assessment of fluorinated substances in cosmetic products*. In Survey of chemical substances in consumer products, (169). https://www2.mst.dk/Udgiv/publications/2018/10/978-87-93710-94-8.pdf. Link.

11 Schellenberger, S., JönssonC., Mellin, P., Levenstam, O. A., Liagkouridis, I., Ribbenstedt, A., Hanning, A., Schultes, L., Plassmann, M. M., & Persson, C. (2019). Release of sidechain fluorinated polymer containing microplastic fibers from functional textiles during washing and first estimates of perfluoroalkyl acid emissions. *Environmental Science & Technology*, 53(24), 14329–14338. https://pubs.acs.org/doi/10.1021/acs.est.9b04165. Link.

12 Hu, X., Andrews, D. Q., Lindstrom, A. B., Bruton, T. A., Schaider, L. A., Grandjean, P., Lohmann, R., Carignan, C. C., Blum, A., & Balan, S. A. (2016). Detection of poly and perfluoroalkyl substances (PFASs) in US drinking water linked to industrial sites, military fire training areas, and wastewater treatment plants. *Environmental Science & Technology Letters*, 3(10), 344–350. https://doi.org/10.1021/acs.estlett.6b00260. Link.

13 European Food Safety Authority. (2018). *Contaminants update: first of two opinions on PFAS in food*. European Food Safety Authority. https://www.efsa.europa.eu/en/press/news/181213. Link.

14 Nakayama, Shoji F, Yoshikane, M., Onoda, Y., Nishihama, Y., IwaiShimada, M., Takagi, M., Kobayashi, Y., & Isobe, T. (2019). Worldwide trends in tracing poly and perfluoroalkyl substances (PFAS) in the environment. *TrAC Trends in Analytical Chemistry*, 121, 115410. https://www.sciencedirect.com/science/article/pii/S0165993618306605?via%3Dihub. Link.

15 Centers for Disease Control and Prevention. (2019). *Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables*. In Centers for Disease Control and Prevention (p.). https://www.cdc.gov/exposurereport/. Link.

16 Bjerregaard Olesen, C., Bossi, R., Liew, Z., Long, M., Bodil, B., Olsen, J., Henriksen, T. B., Berg, V., Nøst, T. H., & Zhang, J. J. (2017). Maternal serum concentrations of perfluoroalkyl acids in five international birth cohorts. *International Journal of Hygiene and Environmental Health*, 220(2), 86–93. https://doi.org/10.1016/j.ijheh.2016.12.005. Link.

17 Dobraca, D., Israel, L., McNeel, S., Voss, R., Wang, M., Gajek, R., Park, J., Harwani, S., Barley, F., & She, J. (2015). *Biomonitoring in California firefighters: metals and perfluorinated chemicals*. Journal of Occupational and Environmental Medicine, 57(1), 88. https://doi.org/10.1097/JOM.0000000000000307. Link.

18 C8 Science Panel. (2020). *C8 Science Panel Website*. C8 Science Panel. http://www.c8sciencepanel.org/panel.html. Link.

19 Grandjean, P., Heilmann, C., Weihe, P., Nielsen, F., Mogensen, U., Timmermann, A., & BudtzJørgensen, E. (2017). Estimated exposures to perfluorinated compounds in infancy predict attenuated vaccine antibody concentrations at age 5 years. *Journal of Immunotoxicology*, 14(1), 188–195. https://doi.org/10.1080/1547691X.2017.1360968. Link.

20 Grandjean, P., Amalie, C., Kruse, M., Nielsen, F., Vinholt, Pernille Just, Boding, L., Heilmann, C., & Mølbak, K. (2020). Severity of COVID-19 at elevated exposure to perfluorinated alkylates. *PloS One*, 15(12), e0244815. https://doi.org/10.1371/journal.pone.0244815. Link.

21 Vernez, D., Bruzzi, R., Kupferschmidt, H., DeBatz, A., Droz, P., & Lazor, R. (2006). Acute respiratory syndrome after inhalation of waterproofing sprays: a posteriori exposure response assessment in 102 cases. *Journal of Occupational and Environmental Hygiene*, 3(5), 250–261. https://doi.org/10.1080/15459620600628845. Link.

22 Lazor Blanchet, C., Rusca, S., Vernez, D., Berry, R., Albrecht, E., Droz, P., & Boillat, M. (2004). Acute pulmonary toxicity following occupational exposure to a floor stain protector in the building industry in Switzerland. *International Archives of Occupational and Environmental Health*, 77(4), 244–248. https://doi.org/10.1007/s00420-004-0505-6. Link.

23 Cousins, I. T., Goldenman, G., Herzke, D., Lohmann, R., Miller, M., Ng, C. A., Patton, S., Scheringer, M., Trier, X., & Vierke, L. (2019). The concept of essential use for determining when uses of PFASs can be phased out. *Environmental Science: Processes & Impacts*, 21(11), 1803–1815. https://doi.org/10.1039/C9EM00163H. Link.

24 Hunt, K. (2019). *Denmark just became the first country to ban PFAS "forever chemicals" from food packaging*. CNN. https://www.cnn.com/2019/09/04/health/denmark-pfas-food-packaging-ban-intl/index.html#:~:text=(CNN)%20Denmark%20will%20be%20the,food%20packaging%2C%20starting%20next%20year. Link.

25 Washington State Legislature. *Firefighting agents and equipment - toxic chemical use*, Chapter 70.75A (2018). https://app.leg.wa.gov/RCW/dispo.aspx?cite=70.75A.020. Link.

26 California Department of Toxic Substances Control. (2020). *Proposed Priority Product: Carpets and Rugs with Perfluoroalkyl and Polyfluoroalkyl Substances (PFASs)*. Department of Toxic Substances Control. https://dtsc.ca.gov/scp/carpets-and-rugs-with-perfluoroalkyl-and-polyfluoroalkyl-substances-pfass/. Link.

27 Department of the Environment. (2018). *San Francisco Department of the Environment Regulation #SFE 207 8-01-PPO/GBRCBO Adopting Approved Alternative Products for Sustainable Carpet for City Departments*. https://sfenvironment.org/sites/default/files/policy/regulation_sfe-2018-01-ppo_gbrcbo.pdf. Link.

28 Akbari, H., Berdahl, P., Levinson, R., Wiel, S., Miller, B., & Desjarlais, A. (2006). *Cool Color Roofing Materials*. CA: Lawrence Berkeley National Laboratory Berkeley. https://www.coolrooftoolkit.org/wp-content/uploads/2012/04/CEC-500-2006-067.pdf. Link.

29 EDCO. (2020). *Infiniti Textured Metal Shake Roofing*. EDCO Products. https://www.edcoproducts.com/products/steel-roofing/roofing-infiniti-textured-shake.html. Link.

30 American Coatings Association. (2020). *Fluoropolymer Coatings for Architectural Applications*. American Coatings Association. https://www.paint.org/coatingstech-magazine/articles/fluoropolymer-coatings-for-architectural-applications/. Link.

31 McKeen, L. W. (2015). *Fluorinated coatings and finishes handbook: The definitive user's guide*. William Andrew. ISBN: 978-0-8155-1522-7.

32 National Roofing Contractors Association. (2004). *Low-Slope Roof Materials Guide. National Roofing Contractors Association*. http://docserver.nrca.net/technical/8336.pdf. Link.

33 Berdahl, P., Akbari, H., Levinson, R., & Miller, W. A. (2008). Weathering of roofing materials–an overview. *Construction and Building Materials*, 22(4), 423–433. https://doi.org/10.1016/j.conbuildmat.2006.10.015. Link.

34 McElroy Metal. (2020). *Energy Star Roofing - Cool Metal Roofing - Kynar | McElroy Metal*. McElroy Metal. https://www.mcelroymetal.com/green-building-solar-metal-roofing/energy-star-roofing. Link.

35 Energy Star Certified. (2020). Product Finder — *ENERGY STAR Certified Roof Products*. Energy Star. https://www.energystar.gov/productfinder/product/certified-roof-products/results?formId=e5ce7d51-489b-461e-b7eb-fd37973a2344&scrollTo=596&search_text=SMP&energy_star_partner_isopen=0&brand_name_isopen=0&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=initial_solar_reflectance&sort_direction=desc¤tZipCode=94103&page_number=0&lastpage=0. Link.

36 Roof Slope. (2016). R*oofing Granules & Their Role on Flat Commercial Roofs*. RoofSlope. https://roofslope.com/roofing-granules-role-flat-commercial-roofs/. Link.

37 Bai, F., Budd, K. D., Everman, R. L., & Lindsay, C. W. (2015). *High Solar Reflectivity Roofing Granules Utilizing Low Absorption Components* (USPTO Patent). Google Patents. https://patents.google.com/patent/US20150113901A1/en. Link.

38 Shiao, M. L., Hong, K. C., Kalkanoglu, Husnu M, & Jacobs, G. F. (2013). *Solar heat reflective roofing granules, solar heat reflective shingles, and process for producing same*. (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/d8/88/69/4e2d9b945c8d1b/US8361597.pdf. Link.

39 3M. (2020a). 3M™ *Classic Roofing Granules*. 3M. https://www.3m.com/3M/en_US/company-us/all-3m-products/~/All-3M-Products/Manufacturing/Design-Specialty-Materials/Architecture-Construction/Classic-Roofing-Granules/?N=5002385+8709320+8709346+8710647+8711017+8720608+3294857497&rt=r3. Link.

40 Levinson, R., Akbari, H., Berdahl, P., Wood, K., Skilton, W., & Petersheim, J. (2010). A novel technique for the production of cool colored concrete tile and asphalt shingle roofing products. *Solar Energy Materials and Solar Cells*, 94(6), 946–954. https://doi.org/10.1016/j.solmat.2009.12.012. Link.

41 Hanrahan, K., Wood, K., Hedhli, L., Gupta, R., & Skilton, W. (2010). *Highly weatherable roof coatings containing aqueous fluoropolymer dispersions* (USPTO Patent). Google Patents. https://patents.google.com/patent/US7803867B2/en. Link.

42 Peng, L. R. (2009). *Roofing Membranes including Fluoropolymers* (USPTO Patent). https://patentimages.storage.googleapis.com/b1/94/ed/9775fbde933e93/US20090181216A1.pdf. Link.

43 GAF. (2016). Kymax™ *Coating Product Data Sheet*. In GAF. https://www.gaf.ca/Commercial_Roofing_Systems/Liquid_Applied_Roofing/Roof_Coatings/UNITED_COATINGS_Kymax_Coating/UNITED_COATINGS_Kymax_Coating_Data_Sheet.pdf. Link.

44 AGC Chemical Company. (2021). *F-CLEAN™ Greenhouse Films - AGC Chemicals*. AGC Chemicals. https://www.agcchem.com/products/specialty-materials/f-clean-greenhouse-film/. Link.

45 Johnston, C. J., Finkelstein, J. N., Mercer, P., Corson, N., Gelein, R., & Oberdörster, G. (2000). Pulmonary effects induced by ultrafine PTFE particles. *Toxicology and Applied Pharmacology*, 168(3), 208–215. https://doi.org/10.1006/taap.2000.9037. Link.

46 Kynar Aquatec. (2017). *Cool Roof Coatings: Guide Specifications*. In Kynar Aquatec. https://www.kynaraquatec.com/files/live/sites/arkema_kynaraquatec/files/downloads/literature-brochures/070513-cool-roof-coatings-with-kynar-aquatec.pdf. Link.

47 Uni-Systems. (2018). En Fold. *En-Fold® Retractable Awning by Uni-Systems*. https://www.uni-systems.com/enfold. Link.

48 FabricArchitect. (2020). *Material Choices: ETFE and PTFE*. Fabric Architect. http://fabricarchitect.com/design-and-material-choices.html. Link.

49 Shade to Order. (2020, April 27). *Technical Information*. Shade to Order. https://shadetoorder.com/technical-information/. Link.

50 Mitchell, R., & Blake, C. (2020, March 6). *Roof Designed to Let Light in, Keep Heat Out at Globe Life Field*. NBC 5 Dallas-Fort Worth; NBC 5 Dallas-Fort Worth. https://www.nbcdfw.com/news/sports/roof-designed-to-let-light-in-keep-heat-out-at-globe-life-field/2324740/. Link.

51 Chilton, J. (2010). *Tensile structures–textiles for architecture and design*. In Textiles, polymers and composites for buildings. Elsevier. http://irep.ntu.ac.uk/id/eprint/3779. Link.

52 Libby, B. (2016). *Experiencing the Outdoors Inside the New Minnesota Vikings Stadium*. Architect. https://www.architectmagazine.com/technology/experiencing-the-outdoors-inside-the-minnesota-vikings-stadium_o. Link.

53 Rain Pro Construction of Yakima, LLC. (2013). *About.* Rain Pro Yakima. http://www.rainproyakima.com/about.html#:~:text=Tests%20have%20shown%20that%20Dura,simple%20as%20aiming%20a%20hose. Link.

54 Star Building Systems. (2021). *Color Chart Selections*. In Star Buildings. https://www.starbuildings.com/pdfs/colorchart/STAR-colorchart_R8_CS5.pdf. Link.

55 Duro-Shield Coatings and Materials. (2020). *Duro-Sheild™ Roof Coatings Compositions* [Phone Call to Seth Rojello Fernández]. In Duro-last. https://duro-last.com/duroshield. Link.

56 Brandenburger, L., Best, T. R., & Yassin, A. H. (2008). *Durable polyester coating* (USPTO Patent). Google Patents. https://patents.google.com/patent/US7381472B2/en. Link.

57 Home Depot. (2020a). *Types of Gutters*. The Home Depot. https://www.homedepot.com/c/ab/types-of-gutters/9ba683603be9fa5395fab901cb1e4465. Link.

58 Pilcher, J. M. (2004). *Enclosed rain gutter* (USPTO Patent). Google Patents. https://patents.google.com/patent/US6688045B1/en. Link.

59 Landry, V., & Blanchet, P. (2012). Weathering resistance of opaque PVDF-acrylic coatings applied on wood substrates. *Progress in Organic Coatings*, 75(4), 494–501. https://doi.org/10.1016/j.porgcoat.2012.06.004. Link.

60 Glüge, J., Scheringer, M., Cousins, I., DeWitt, J. C., Goldenman, G., Herzke, D., Lohmann, R., Ng, C., Trier, X., & Wang, Z. (2020). An overview of the uses of per- and polyfluoroalkyl substances (PFAS). *EngrXiv*. https://engrxiv.org/2eqac/. Link.

61 Norden. (2021). *SPIN | Substances in Preparations in Nordic Countries*. Norden; Nordic Council of Ministers Chemical Group. http://spin2000.net/. Link.

62 Malshe, V., Elango, S., Bhagwat, S., & Maghrabi, S. (2005). Fluorinated acrylic copolymers: part II: polymeric surfactants. *Progress in Organic Coatings*, 53(3), 212–216. https://doi.org/10.1016/j.porgcoat.2005.03.004. Link.

63 Kissa, E. (2001). *Fluorinated surfactants and repellents* (Second Edition, Vol. 97). CRC Press. https://doi.org/10.1021/ja015260a. Link.

64 Teflon™. (2020). *Teflon™ Surface Protector for Paint*. Teflon. https://www.teflon.com/en/consumers/paint. Link.

65 Branquinho, J., Alves, J., Carvalho, S., Moniz, J., Oliveira, F., & Gil, M. (2009). Fluorinated additives for stain resistant matt latex paints. *Journal of Coatings Technology and Research*, 6(4), 1–9. https://doi.org/10.1007/s11998-009-9170-8. Link.

66 3M. (2020c). *Stain Resistant Additive and Sealer SRC-220*. 3M; MMM-ext. https://www.3m.com/3M/en_US/company-us/all-3m-products/~/3M-Stain-Resistant-Additive-and-Sealer-SRC-220/?N=5002385+3292678652&rt=rud. Link.

67 SEI Chemicals. (2006). *Anti-graffiti coating antigraffiti coating anti-stick non-stick*. SEI Chemicals. http://www.seichemical.com/products/GPA-proofer_anti_stick.html. Link.

68 Dumond Chemicals. (2020). *Watch Dog CPU 647 - Specification and Data Sheet*. Dumond Chemicals, Inc. https://www.dumondchemicals.com/pdf/TDS/CPU%20647%20TDS.pdf. Link. [Retrieved July 8, 2020]

69 Daikin. (2019). *Binders for Coatings | DAIKIN*. Daikin Chemicals. https://www.daikinchem.de/products-and-performance/binders-coatings. Link.

70 Daikin. (2018). *Weatherable Coating Resin - ZEFFLE GK-580*. In Daikin Chemicals. https://www.daikinchemicals.com/library/pb_common/pdf/tds/Coatings_resins_and_additives/ZEFFLE_GK_Series/tds-gk-580-E_ver01_Mar_2018.pdf. Link.

71 AGC Chemicals Company. (2016). *Lumiflon® Functions and Features*. AGC-Chemicals.com. https://www.agc-chemicals.com/jp/en/fluorine/products/detail/index.html?pCode=JP-EN-F002. Link.

72 Powder Coating Institute. (2016a). Powder Coating on Wood - Powder Coating Institute. Powder Coating Institute; The Powder Coating Institute. https://www.powdercoating.org/page/PConWood. Link.

73 Powder Coating Institute. (2016b). *What is Powder Coating? - Powder Coating Institute*. Powder Coating Institute; The Powder Coating Institute. https://www.powdercoating.org/page/WhatIsPC. Link.

74 Solvay. (2020a). *Halar® 6014*. Solvay. https://www.solvay.com/en/product/halar-6014. Link.

75 IFS Coatings. (2020). *Fluoropolymer Powder Coatings*. IFS Coatings. https://www.ifscoatings.com/content/ifs-powder-products/ifs-fluoropolymers/. Link.

76 Hennessey, C. K. (2009). *Process for applying fluoropolymer powder coating as a primer layer and an overcoat*. (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/ca/36/de/a86a99c5c95e18/US7601401.pdf. Link.

77 USDA. (1999). *Appendix D-Paint Binders*. U.S. Forest Service. https://www.fs.fed.us/eng/pubs/htmlpubs/htm98712814/apndxd.htm. Link.

78 Arkema. (2020). *Binder choices for metal coatings*. Arkema Coating Resins. https://americas.arkemacoatingresins.com/en/products/spotlights/binder-choices-for-metal-coatings/. Link.

79 Zinsser. (2020). *Paintbooster™ Flow Control Additive For Oil-Based Paints*. In Rust-Oleum. https://www.rustoleum.com/~/media/DigitalEncyclopedia/Documents/RustoleumUSA/TDS/English/CBG/Zinsser/PaintBooster_TDS_Flow_Control_Additive_Oil_Base.ashx. Link.

80 Wood, K. A. (2014). How can we effectively use accelerated methods to predict the decorative properties of PVDF based coatings?–A practical approach. *Progress in Organic Coatings*, 77(12), 2140–2146. https://doi.org/10.1016/j.porgcoat.2013.12.011. Link.

81 AGC Chemicals Company. (2020b). *SURECO™*. AGC-Chemicals.com. https://www.agcchem.com/products/specialty-materials/sureco/. Link.

82 Darden, W. (2018). *Toward a 100 Year Bridge Coatings System: Bridge Topcoats in Japan*. In American Institute of Steel Construction. https://www.aisc.org/globalassets/nsba/conference-proceedings/2018/2018-wsbs-final-paper---darden.pdf. Link.

83 DuPont. (2015). *DuPont™ Snow & Ice Non-Stick Clear Coating with Teflon® Fluoropolymer*. Performance Lubricants USA. http://www.performancelubricantsusa.com/product/snow-and-ice-repellent.php. Link.

84 Moses, J. (2019, November). *The Evolution of Coil Coatings and Paint Systems for Metal. Metal Construction News*; Metal Architecture. https://www.metalconstructionnews.com/articles/the-evolution-of-coil-coatings-and-paint-systems-for-metal. Link.

85 International Living Future Institute. (2017a). *190/350/500 Standard Entrances*. In International Living Future Institute. https://declare.living-future.org/products/190-350-500-standard-entrances. Link.

86 International Living Future Institute. (2017b). *HES 1006 Series Strike*. In International Living Future Institute. https://declare.living-future.org/products/hes-1006-series-strike. Link.

87 International Living Future Institute. (2019b). *Norton 600 Door Operator.* International Living Future Institute. https://declare.living-future.org/products/norton-6000-door-operator. Link.

88 Health Product Declaration Collaborative. (2019a). *Continuous Hinge*. In HPD Collaborative (pp. 1–14). https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_234_Continuous_Hinge.pdf. Link.

89 Health Product Declaration Collaborative. (2019b). *Steel Door.* In HPD Collaborative. https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_646_Steel_Door.pdf. Link.

90 Health Product Declaration Collaborative. (2020a). *SARGENT 10 Line Cylindrical Lock*. In HPD Collaborative. https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_11_SARGENT_10_Line_Cylindrical_Lock.pdf. Link.

91 Norton Assa Abloy. (2016). *Yale 4400 Door Closer by Assa Abloy.* In Norton Door Controls. https://www.nortondoorcontrols.com/Other/Norton/Sustainability/Health%20Product%20Declaration/HPD%20NOR%207500%20Door%20Closer.pdf. Link.

92 Akzo Nobel. (2019). *CERAM-A-STAR®: The industry's best SMP Coil Coatings*. Akzonobel. https://coilcoatings.akzonobel.com/us/ceram-a-star. Link.

93 Bouchama, L., Azzouz, N., Boukmouche, N., Chopart, J., Daltin, A., & Bouznit, Y. (2013). Enhancing aluminum corrosion resistance by two step anodizing process. *Surface and Coatings Technology*, 235, 676–684. https://doi.org/10.1016/j.surfcoat.2013.08.046. Link.

94 Aluminum Anodizers Council. (2020). *What are the Benefits of Anodizing Aluminum? | AAC*. Anodizing. https://www.anodizing.org/page/anodizing-benefits. Link.

95 Home Depot. (2020b). *Types of Nails*. The Home Depot. https://www.homedepot.com/c/ab/types-of-nails/9ba683603be9fa5395fab909c451e98. Link.

96 Fan, W. (2016). *Evaluating Fluoropolymer-Based Stain-Resistant Additives and Sealers*. Paints & Coatings Industry; PCI Magazine. https://www.pcimag.com/articles/101825-evaluating-fluoropolymer-based-stain-resistant-additives-and-sealers. Link.

97 Daikin. (2020c). *Resins and Additives | Fluorochemicals*. Daikin Chemicals. https://www.daikinchemicals.com/solutions/products/coatings-resins.html. Link.

98 ECOS Paints. (2020). *ECOS Wood Stain*. ECOS Paints. https://www.ecospaints.net/WoodShield-Wood-Stain. Link.

99 Gao, H., Zhang, J., & Leach, R. (2006). *Polymer and water repellent compositions for wood product dimensional stability* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/07/56/7a/7b7fa9d551174a/US20060100340A1.pdf. Link.

100 Sigel, G. A., Roodman, J. A., Bakder, D. P., & Winey, R. L. (2018). *Surface covering having an improved wear layer* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/07/24/8f/fa9d154f247bdc/US20180327606A1.pdf. Link.

101 Tullo, A. H. (2012). *Modifying Wood To Last, With Chemistry*. Chemical & Engineering News; American Chemical Society. https://cen.acs.org/articles/90/i32/Making-Wood-Last-Forever-Acetylation.html. Link.

102 Accsys. (2020). *What is Acetylation?* Accsys Technologies PLC. https://www.accsysplc.com/products/what-is-acetylation/. Link.

103 Rowell, R. M., Ibach, R. E., McSweeny, J., & Nilsson, T. (2009). Understanding decay resistance, dimensional stability and strength changes in heat-treated and acetylated wood. *Wood Material Science and Engineering*, 4(1-2), 14–22. https://doi.org/10.1080/17480270903261339. Link.

104 Trex. (2021). *What You Need To Know About Trex vs Plastic Decking*. Trex. https://www.trex.com/why-trex/composite-vs-plastic-decking/#:~:text=Composite%20decking%E2%80%94like%20Trex%E2%80%94is,stable%20than%20100%25%20plastic%20decking. Link.

105 Dallas Bathtub Refinishing. (2018). *Polyceramic synthetic porcelain, bathtub refinishing, finish coat*. Synthetic Porcelain. https://syntheticporcelain.weebly.com/. Link.

106 Toft, A., Crabb, C. C., Banyay, H. R., & Burchill, M. (2015). *Fluoropolymer modified acrylic capstock* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/4b/50/c7/f8c49c36e9a44b/US9056974.pdf. Link.

107 Schneider, R. W. (2010). *Dry erase writing board and method* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/fb/55/fe/ecbdbe256b92f4/US7713375.pdf. Link.

108 Health Product Declaration Collaborative. (2020b). *Wall talkers MagRite Dry Erase Wallcovering*. In HPD Collaborative. https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_532_Walltalkers_MagRite_Dry_Erase_Wallcovering.pdf. Link.

109 California Department of Toxic Substances Control. (2019a). *Product -Chemical Profile for Carpets and Rugs Containing Perfluoroalkyl or Polyfluoroalkyl Substances*. In California Department of Toxic Substances Control. https://dtsc.ca.gov/wp-content/uploads/sites/31/2020/02/Final_Product-Chemical_Profile_Carpets_Rugs_PFASs_a.pdf. Link.

110 Kubwabo, C., Stewart, B., Zhu, J., & Marro, L. (2005). Occurrence of perfluorosulfonates and other perfluorochemicals in dust from selected homes in the city of Ottawa, Canada. *Journal of Environmental Monitoring*, 7(11), 1074–1078. https://doi.org/10.1039/b507731c. Link.

111 Gewurtz, S. B., Bhavsar, Satyendra P, Crozier, P. W., Diamond, M. L., Helm, P. A., Marvin, C. H., & Reiner, E. J. (2009). Perfluoroalkyl contaminants in window film: indoor/outdoor, urban/rural, and winter/summer contamination and assessment of carpet as a possible source. *Environmental Science & Technology*, 43(19), 7317–7323. https://doi.org/10.1021/es9002718. Link.

112 Vestergren, R., Cousins, I. T., Trudel, D., Wormuth, M., & Scheringer, M. (2008). Estimating the contribution of precursor compounds in consumer exposure to PFOS and PFOA. *Chemosphere*, 73(10), 1617–1624. https://doi.org/10.1016/j.chemosphere.2008.08.011. Link.

113 Maitland, L. (1982). *Finishes to Help Fabrics Stay Clean*. The New York Times. https://www.nytimes.com/1982/07/01/garden/finishes-to-help-fabric-stay-clean.html?pagewanted=all. Link.

114 Beesoon, S., Genuis, S. J., Benskin, J. P., & Martin, J. W. (2012). Exceptionally high serum concentrations of perfluorohexanesulfonate in a Canadian family are linked to home carpet treatment applications. *Environmental Science & Technology*, 46(23), 12960–12967. https://doi.org/10.1021/es3034654. Link.

115 Shaw. (2019). *Shaw - PFAS*. Shaw. https://shawinc.com/ShawPFAS. Link.

116 Tarkett. (2017). *Advanced Treatment Applied to Tandus Centiva- Branded Soft Surface Products Made in North America*. In Tarkett. https://tandus-production.s3.amazonaws.com/content/file/1177/EcoEnsureReleaseFINAL.pdf. Link.

117 Davis, M. (2019). *Three Big Myths About Chemicals in Carpet*. Interface. https://blog.interface.com/three-big-myths-chemicals-carpet/. Link.

118 Floor Trends. (2019). Engineered Floors Promotes Healthier Spaces with PureColor PET. *Floor Trends Magazine*; https://www.floortrendsmag.com/articles/104492-engineered-floors-promotes-healthier-spaces-with-purecolor-pet. Link.

119 Home Depot. (2019). *Phasing Out Products Containing PFAS*. The Home Depot. https://corporate.homedepot.com/newsroom/phasing-out-products-containing-pfas#.XYD8x-3waIo.twitter. Link.

120 Lowe's. (2020). *Lowe's Safer Chemicals Policy*. Lowe's Corporate. https://corporate.lowes.com/our-responsibilities/corporate-responsibility-reports-policies/lowes-safer-chemicals-policy. Link.

121 Danish Ministry of the Environment. (2015). *Alternatives to perfluoroalkyl and polyfluoro- alkyl substances (PFAS) in textiles*. In Danish Ministry of the Environment. https://www2.mst.dk/Udgiv/publications/2015/05/978-87-93352-16-2.pdf. Link.

122 Green Science Policy Institute. (2019). *PFAS-Free Products - PFAS Central*. PFAS Central. https://pfascentral.org/free. Link.

123 Floor Biz. (2020). *Flooring News: Mannington Incorporates DuPont's Teflon Into Hard Surface - FloorBiz.com Flooring News*. Floor Biz. http://www.floorbiz.com/BizNews/NPViewArticle.asp?ArticleID=275. Link.

124 CongoAdmin. (2016). *Benefits of Resilient*. Congoleum. https://www.congoleum.com/benefits-of-resilient/. Link.

125 3M. (1992). *Presenting the solutions to your problems*. In The Office of Minnesota's Attorney General. The Office of Minnesota Attorney General. https://www.ag.state.mn.us/Office/Cases/3M/docs/PTX/PTX1370.pdf. Link.

126 Dow. (2020). *DURAGREEN™ 4373 Floor Finish Polymer*. In Dow Chemicals. https://www.dow.com/content/dam/dcc/documents/en-us/productdatasheet/27/27-23/27-2330-01-duragreen-4373-floor-finish-polymer.pdf?iframe=true. Link.

127 Hills, D., & Barrus, K. (2019). *Methods for polishing flooring surfaces* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/3e/fb/35/7b4bf51f0e4e3e/US10322485.pdf. Link.

128 Micro Powders, Inc. (2015). *High Performance Wax Additives: Advanced technology with a quality difference*. In Paints & Coatings Industry. https://www.pcimag.com/ext/resources/VirtualBrochure/MicroPowder.pdf. Link.

129 3M. (2015a). *3M Stain Resistant Additives and Sealers*. 3M. https://multimedia.3m.com/mws/media/750888O/3m-stain-resistant-additives-and-sealers-brochure.pdf. Link.

130 Concrete Sealers USA. (2019). *Safety Data Sheet (SDS) PS100 Fluorinated Water, Oil & Salt Repellent WB Penetrating Sealer*. https://www.concretesealersusa.com/content/pdfs/PS100SafetyDataSheet.pdf. Link.

131 Li, J., Tarng, M., Fan, X., & Shi, J. (2014). *Coating composition for ice and snow removal on cementitious surfaces* (USPTO Patent). Google Patents. https://patents.google.com/patent/US20140010965A1/en. Link.

132 Deepshield. (2020). *Gold Transparent Penetrating Sealer*. Deepshield. https://www.deepshield.com.au/Gold-Transparent-Penetrating-Sealer. Link.

133 L&M Construction Chemicals, Inc. (2005). *PETROTEX*. In Elegant Polishing. http://elegantpolishing.com/wp-content/uploads/2013/07/Petrotex.pdf. Link. [Retrieved October 28, 2020]

134 Tile Council of North America. (2020). *Epoxy Grout*. Tile Council of North America. https://www.tcnatile.com/faqs/37-epoxy-grout.html. Link.

135 Tilelab®. (2005). *Tilelab® Surfacegard® Penetrating Sealer*. In The Home Depot. https://images.homedepot-static.com/catalog/pdfImages/6c/6c6aefa7-b771-4378-b4b7-8a2ace15f311.pdf. Link.

136 Culkin, B., Questel, R., Harrington, R., Croteau, D., Thottathil, P., Kesavan, P., Ryan, J., & Mukherjee, S. (2020). *Natural stone sealer compositions* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/44/b4/4c/71eee6a0942157/US10532956.pdf. Link.

137 Consumer Product Safety Commission. (2016, May 19). CPSC, *Tile Perfect Inc. Announce Recall of Stand'n Seal Grout Sealer Due to Respiratory Problems*. U.S. Consumer Product Safety Commission. https://www.cpsc.gov/Recalls/2005/cpsc-tile-perfect-inc-announce-recall-of-standn-seal-grout-sealer-due-to-respiratory. Link.

138 Patrick, D. G., Spiller, H. A., Crouch, B. I., Seiferta, S. A., Simone, K. E., & Smolinske, S. C. (2009). Pulmonary toxicity following exposure to waterproofing grout sealer. *Journal of Medical Toxicology*, 5(3), 125–129. https://doi.org/10.1007/BF03161222. Link.

139 Keese, D. (2019, April 26). *Tile Guard Silicone Grout Sealer*. Seal with Ease; https://sealwithease.com/tile-guard-silicone-grout-sealer-review/. Link.

140 Petrie, E. M. (1999). *Handbook of adhesives and sealants*. McGrawHill. https://users.fs.cvut.cz/libor.benes/vyuka/lepeni/Handbook%20of%20Adhesives%20and%20Sealants.pdf. Link.

141 Pelseal Technologies, LLC. (2017). *Fluoroelastomer Resists Alkali, High pH, Aminos - Pelseal Technologies*. Pelseal Technologies, LLC. https://www.pelseal.com/newsroom/pelseal-introduces-aflas-fluoroelastomer. Link.

142 Hoover, G. S., & Jr, R. (2002). *High solids fluoroelastomer compositions* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/72/35/17/3b324350637e62/US6410630.pdf. Link.

143 Dent, S. J., Rong, W., Steinbrecher, J. W., & Strong, M. R. (2018). *Fluorinated copolymer compositions and associated methods, uses and articles* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/85/1d/6a/1c98a4c174e870/US9957359.pdf. Link.

144 Braun, A., & Huck, W. R. (2007). *Aqueous adhesion promoting cleaner composition for increasing the adhesion of adhesives and sealants to paints* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/83/4b/4b/0ebf7603a5cc19/US20070187028A1.pdf. Link.

145 Grainger. (2020). *Caulks and Sealants*. Grainger. https://www.grainger.com/search/adhesives-sealants-and-tape/caulks-sealants-and-fillers/caulks-and-sealants?tv_optin=true&searchQuery=dap+silicone+caulk&ef_id=CjwKCAiAq8f-BRBtEiwAGr3DgYS8UlVXaGDscH2iKo4buEWaeXUflanByPla1ZXCRbtlgybAWwoyVxoChh4QAvD_BwE:G:s&s_kwcid=AL!2966!3!317451745593!b!!g!!&gucid=N:N:PS:Paid:GGL:CSM-2296:9JMEDM:20500731. Link.

146 Home Depot. (2020c). *Viton Products: Plumbing*. The Home Depot. https://www.homedepot.com/b/Plumbing/N-5yc1vZbqew/Ntk-RelaxedMatch/Ntt-viton?NCNI-5&experienceName=default&storeSelection=627,1007,643,625,1044. Link.

147 Melon. (2017). *NBR Viton Sponge Rubber Toilet Washer Sanitary Ruber Sealing Washer Manufacturer Factory Price Moulded Rubber Parts Free Design*. Melon Rubber. https://www.melon-rubber.com/nbr-viton-sponge-rubber-toilet-washer-sanitary-ruber-sealing-washer-manufacturer-factory-price-moulded-rubber-parts-free-design-p-26.html. Link.

148 PVC Pipe Supplies. (2020). *Viton Products*. Pvcpipesupplies.com. https://pvcpipesupplies.com/catalogsearch/result/index/?p=1&q=viton. Link.

149 Jomar Valve. (2020). *Lead Free Brass Ball Valve*. In https://www.jomarvalve.com/specsheets/TWV-3W-KIT-G-1.pdf. Link.

150 Cliff. (2018). *The Advantages and Disadvantages of PTFE O-Rings*. Eclipse Engineering, Inc. https://eclipseseal.com/blog/seals/advantages-disadvantages-ptfe-o-rings/. Link.

151 Moore, A. L., & Drobny, Jiri George. (2006). *Fluoroelastomers handbook: the definitive user's guide and databook*. Taylor & Francis. ISBN: 978-0-8155-1517-3.

152 DuPont. (2013). *DuPont™ Capstone® Fluorosurfactants For High Value-In-Use Applications That Require Maximum Performance*. In ChemPoint. https://cms.chempoint.com/ChemPoint/media/ChemPointSiteMedia/PDF%20Docs/K-24287-1-DuPont-Capstone-Fluorosurfactants-Brochure_1.pdf. Link.

153 Parikh, D., Chum, P., Patel, R., Kummer, K., Jain, P., McKeand, T., Markovich, R. P., Clayfield, T. E., & Khan, W. A. (1999). *Polyolefin elastomer blends exhibiting improved properties* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/73/97/02/db889a25209eb0/US6005053.pdf. Link.

154 3M. (2011). *Easy Clean Coating ECC-7000 For Ceramic and Glass Substrates*. In 3M. https://multimedia.3m.com/mws/media/1063806O/easy-clean-coating-ecc-7000.pdf. Link.

155 Zheng, M., Wen, M., Gaboury, S. R., Wood, K. A., & Partridge, R. H. (2019). *Aqueous fluoropolymer glass coating* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/91/36/31/45d31e6aa957d7/US10399892.pdf. Link.

156 Karagiannis, A., Ma, Y., & Schimmelpenningh, J. C. (2008). *Polymer sheets comprising a fluoropolymer* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/7c/3b/b2/693abd43f46849/US7399525.pdf. Link.

157 3M. (2004). *Easy Clean Coating ECC-3000*. In 3M. https://multimedia.3m.com/mws/media/1063804O/easy-clean-coating-ecc-3000.pdf. Link.

158 Enduroshield. (2016). *Enduroshield Glass Home (US)*. In Enduroshield. https://www.enduroshield.com/en//wp-content/uploads/2016/11/ENDUROSHIELD%20GLASS%20HOME%20(US)%20GHS.pdf. Link.

159 DeVito, R. (2020). *Omniphobic Coating Suite | MSU Technologies*. Michigan State University. https://web.archive.org/web/20190715083626/https://technologies.msu.edu/omniphobic-coatings. Link.

160 Khan, A., Huang, K., Sarwar, M. G., & Rabnawaz, M. (2020). High modulus, fluorine free self healing anti smudge coatings. *Progress in Organic Coatings*, 145, 105703. https://doi.org/10.1016/j.porgcoat.2020.105703. Link.

161 Rabnawaz, M., Liu, G., & Hu, H. (2015). Fluorine-free anti-smudge polyurethane coatings. *Angewandte Chemie*, 127(43), 12913–12918. https://doi.org/10.1002/anie.201504892. Link.

162 GE Current. (2020). *75A/RD/STG PQ1/6 120*. Current, Powered by GE. https://catalog.gecurrent.com/catalog/p/46895. Link.

163 Surface Solutions Group, LLC. (2016). *PTFE Coated Glass Labware - Fluoroglass*. Surface Solutions Group, LLC. http://www.surfacesolutionsgroup.com/coatings/fluoroglass/. Link.

164 Orion Industries. (2020). *FluoroGlass Glass Bonding Technology*. Orion Coat. https://www.orioncoat.com/industrial-applications/orion-functional/fluoroglass-coating/. Link.

165 Boucher, M., Ehmler, T., & Bermudez, A. (2000). Polytetrafluoroethylene gas intoxication in broiler chickens. Avian Diseases, 449–453. https://www.jstor.org/stable/pdf/1592561.pdf. Link.

166 California Department of Toxic Substances Control. (2019b). *Product -Chemical Profile for Treatments Containing Perfluoroalkyl or Polyfluoroalkyl Substances for Use on Converted Textiles or Leathers*. In California Department of Toxic Substances Control. https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/11/Product-Chemical-Profile-for-Treatments-with-PFASs.pdf. Link.

167 Boyd, C. (2017). *Upholstery applications of fluorochemicals in the office furniture industry*. In California Department of Toxic Substances Control. https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/10/B1_Clinton-Boyd_PFAS-Workshop_20170131.pdf. Link.

168 IKEA. (2017). *IKEA FAQ Highly Fluorinated Chemicals*. IKEA. https://www.ikea.com/us/en/files/pdf/41/81/41810e8b/ikea_faq_highly_fluorinated_chemicals.pdf. Link.

169 Herman Miller. (2020). *Design for the Environment*. Herman Miller. https://www.hermanmiller.com/our-values/environmental-advocacy/design-for-the-environment/. Link.

170 AKAS Textiles. (2020). *AKAS Manufactures PFOA & PFAS-Free Textiles - AKAS Tex - Fiber to Fabric Solutions*. AKAS Textiles & Laminations. https://akastex.com/akas-manufactures-pfoa-pfas-free-textiles/. Link.

171 Milliken. (2020). *BREATHE by Milliken™*. Breathe by Milliken™. http://breathebymilliken.com/. Link.

172 DetraPel. (2020). *How it works | DetraPel Non-Toxic PFAS-Free Liquid & Stain Repellents*. DetraPel. https://www.detrapel.com/how-it-works/. Link.

173 Green Shield Finish. (2019). *Green Fabric Finish - The Science Behind Our Stain Resistant Finish*. Green Shield Finish. https://greenshieldfinish.com/technology/. Link.

174 Gibbons, J. (2018). *What Exactly is Olefin Fabric?* Revolution Fabrics by the Yard; https://revolutionfabrics.com/blogs/gotcha-covered/what-exactly-is-olefin. Link.

175 Revolution Performance Fabrics. (2020). *Furniture Stores - Revolution Fabric*. Revolution Fabrics by the Yard. https://revolutionfabrics.com/pages/store-locator. Link.

176 International Living Future Institute. (2020). *CertainTeed Decoustics LightFrame by Saint Gobain*. In International Living Future Institute. https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_41_CertainTeed_Decoustics_LightFrame.pdf. Link.

177 DuPont. (2017). *DuPont Tedlar Wallcoverings*. In Tedlar Wallcoverings. https://www.tedlarwallcoverings.dupont.com/content/dam/dupont/amer/us/en/microsites/wallcoverings/public/documents/Technical-DuPont-Tedlar-Wallcovering-Tech-Sheet.pdf. Link.

178 International Living Future Institute. (2019a). *DuPont™ Tedlar™ Wallcoverings - Passport I Collection by E. I. du Pont de Nemours and Company*. https://hpdrepository.hpd-collaborative.org/repository/HPDs/publish_194_DuPont_Tedlar_Wallcoverings_Passport_I_Collection.pdf. Link.

179 Knepper, T. P., & Janousek, R. M. (2019). *Potential SVHCs in environment and products: Measurements of the presence of potential substances of very high concern in the environment and in products*. In Unwelt Bundesamt. https://www.umweltbundesamt.de/en/publikationen/potential-svhcs-in-environment-products. Link.

180 ANIXTER. (2013). *Technical Information Handbook Wire and Cable*. In RM Electrical Solutions. https://www.rmelectricsolutions.com/uploads/8/7/8/4/87841322/wire___cable_technical-handbook-en-us.pdf. Link.

181 Direct Industry. (2020). *UL1213 PTFE wire - Shanghai Shenyuan High Temperature wire Co., Ltd - PDF Catalogs | Technical Documentation | Brochure. Direct Industry by Virtual Expo Group*. https://pdf.directindustry.com/pdf/shanghai-shenyuan-high-temperature-wire-co-ltd/ul1213-ptfe-wire/213841-899654.html. Link.

182 Warmup. (2020). E*lectric Radiant Floor Heating Systems | Warmup USA*. Warmup. https://www.warmup.com/underfloor-heating/electric. Link.

183 Warmzone. (2018). *FoilHeat - Low Profile Radiant Heated Floors from Warmzone*. Warmzone. https://www.warmzone.com/floor-heating/foilheat.php. Link.

184 WinSupply. (2020). *Leading Supplier of Residential and Industrial Supplies | Winsupply*. WinSupply. https://www.winsupplyinc.com/warmup-heating-equipment/_/A-05369907. Link.

185 NFPA. (2017). *NFPA 70® National Electrical Code*. In ToolTexas. https://www.tooltexas.org/wp-content/uploads/2018/08/2017-NEC-Code-2.pdf. Link.

186 KrisTech. (2010, June 29). *Types of Material Used for Wire Insulation*. Kris-Tech Wire. https://www.kristechwire.com/types-of-material-used-for-wire-insulation/. Link.

187 North American Retail Hardware Association. (2020). *Study Guide: Plumbing*. In North American Retail Hardware Association. https://nrha.org/BasicTraining/Plumbing/Plumbing_Study_Guide.pdf. Link.

188 Cauldwell, R. (2009). *Taunton's Plumbing Complete: Expert Advice from Start to Finish*. Taunton Press. ISBN: 1561588555.

189 3M. (2020b). *Scotch® Pipe Thread Sealant Tape 48, 547, PTFE*. In 3M (pp. 1–4). 3M.com. https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSu9n_zu8l00xlYtUnx_vOv70k17zHvu9lxtD7xtBevSSSSSS-. Link.

190 RectorSeal. (2020). *Product Data Sheet: T PLUS 2® Pipe Thread Sealant with PTFE*. In RectorSeal (pp. 1–2). https://rectorseal.com/rectorseal-t-plus-2-group/. Link.

191 Begley, T., White, K., Honigfort, P., Twaroski, M., Neches, R., & Walker, R. (2005). Perfluorochemicals: potential sources of and migration from food packaging. *Food Additives and Contaminants*, 22(10), 1023–1031. https://doi.org/10.1080/02652030500183474. Link.

192 Rodowa, A. E., Christie, E., Sedlak, J., Peaslee, G. F., Bogdan, D., DiGuiseppi, B., & Field, J. A. (2020). Field Sampling Materials Unlikely Source of Contamination for Perfluoroalkyl and Polyfluoroalkyl Substances in Field Samples. *Environmental Science & Technology Letters*, 7(3), 156–163. https://doi.org/10.1021/acs.estlett.0c00036. Link.

193 Rust-Oleum. (2014). *LeakSeal® Self-Fusing Tape*. In Rust-Oleum. https://www.rustoleum.com/~/media/DigitalEncyclopedia/Documents/RustoleumUSA/Product-Documents/IBG%20Product%20Sell%20Sheets/English%20Sell%20Sheets/CS53510514IBGSSLeakSeal%20Tape%20Final%2072314.ashx. Link.

194 Plumbing Supply. (2020). *Plumber's Tape - thread sealing tape, foil tape, strapping tape, colored rescue tape, pipe wrap tape*. Plumbing Supply. https://www.plumbingsupply.com/tapes.html. Link.

195 Hercules. (2017). *Megaloc Thread Sealant*. In Oatey. https://oateyassetcdn.azureedge.net/assets/Document/raw_02_Megaloc_PRODINFO_001.pdf. Link.

196 Hercules Megaloc. (2015). *SDS: Hercules Megaloc*. 3Ei Intelligent Compliance. https://www.3eonline.com/ImageServer/ImageViewer.aspx?id=TMo3WCQBKPPw9IM2ktDPh%2bWaDpQl3JvNPLMD8Gd9ExjB5KWf2xCTn6bktdXDojPyBaNoDlWDO9o2wJWjOprxOnBjbG HnbZYQG8XFroyJQN%2fqR2GkUgUKrK7L%2b8x8r8BrHIjPpfbIeH2NR63f3EnJEtO20yuzttLP1Jax1n%2fHtTgfPi4%2f6%2fXNpRPOnQGj%2bkctRL2UptW%2bpkztt5FTBWccDg%3d%3d. Link.

197 Kashmer, K. (2019, May 17). *Pipe Thread Sealant vs. Pipe Joint Compound*. Pvcfittingsonline.com. https://www.pvcfittingsonline.com/resource-center/pipe-thread-sealant-vs-pipe-joint-compound/. Link.

198 Iruya, K., Yasuda, S., Taguchi, D., & Matsuoka, Y. (2017). *Fluorinated elastomer composition and method for its production, molded product, crosslinked product, and covered electric wire* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/e5/a7/de/3d75482f86ab2b/US9711257.pdf. Link.

199 Taguchi, D., Yasuda, S., & Sato, T. (2017). *Fluorinated elastomer composition and method for its production, molded product, crosslinked product, and covered electric wire* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/3e/3b/86/480f8f3f0fd0cf/US9704616.pdf. Link.

200 Kitahara, T., Isaka, T., Fukagawa, R., & Shiotsuki, K. (2015). *Tetrafluoroethylene/hexafluoropropylene copolymer and the production method thereof, and electrical wire* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/33/f2/e3/aa277dce3ba7bb/US9012580.pdf. Link.

201 Chemours. (2020). *Tefzel™ ETFE 750*. In Teflon. https://www.teflon.com/en/-/media/files/teflon/tefzel-750-appliance-wire-product-info.pdf. Link.

202 Dacon. (2020). *Teflon® Insulated Wire (FEP, PFA, ETFE)*. Dacon. https://dacon.com/custom-wire-manufacturing/teflon-wire-fep-pfa-etfe/. Link.

203 Solvay. (2020b). *Halar® ECTFE*. Solvay. https://www.solvay.com/en/brands/halar-ectfe. Link.

204 Odhner, O. R., & Michaud, J. W. (1983). *Low smoke and flame spread cable construction* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/11/de/85/bdf084123e5a1d/US4401845.pdf. Link.

205 Industrial Tape & Supply Company. (2020). Saint-Gobain SGK5-05 PTFE Para-Aramid Wiring Harness Tape - Industrial Tape and Supply Co. *Industrial Tape & Supply Company*. https://industrialtape.com/catalog/product/2386-saint-gobain-sgk5-05-ptfe-para-aramid-wiring-harness-tape.html. Link.

206 Yamamoto, K., Asano, J., Yamamoto, S., Konishi, T., & Chaen, S. (2003). *Adhesive tape or sheet of nonwoven fluorine-containing resin fabric* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/81/d8/fc/b65bf0db7a6d6f/US20030082973A1.pdf. Link.

207 Cable Ties and More. (2020). *Fiberglass Lacing Tape*. Cable Ties and More. https://www.cabletiesandmore.com/fiberglass-lacing-tape. Link.

208 Katahdin Company. (2020). *Fenestration Industry - Precision Fabric*. Precision Coating. https://www.precisioncoating-ftb.com/industries/fenestration.html. Link.

209 Skyflon. (2020). *PVC Door & Window Production - PTFE Coated Fiberglass Fabrics, Tapes, Belts Manufacturer in China*. Skyflon. http://www.skyflon.com/case/PVC_Door_Window_Production-6.html. Link.

210 Galush, T. B., Clements, G. J., Erickson, J. J., & Deeb, G. S. (2013). *Multilayer Flashing Tape*. (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/9b/5f/dd/15d0f1fd506217/US20130139953A1.pdf. Link.

211 Deng, N., Katsaros, J. D., & Lamontia, M. A. (2013). *Self adhering flashing system having high extensibility and low retraction* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/c3/94/b3/aff8a815b77b22/US8399088.pdf. Link.

212 Sano, M. (2006). *Pressure sensitive adhesive tape or sheet, and method for producing it* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/ea/d6/0e/415cb91b624ae1/US7097892.pdf. Link.

213 Evans, P., & Moore, G. (2018). *Modular carpet systems* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/cd/8c/96/5df703e1e2f25d/US9988760.pdf. Link.

214 Bečanová, J., Melymuk, L., Vojta, Š., Komprdová, K., & Klánová, J. (2016). Screening for perfluoroalkyl acids in consumer products, building materials and wastes. *Chemosphere*, 164, 322–329. https://doi.org/10.1016/j.chemosphere.2016.08.112. Link.

215 Mansouri, H., Thomas, R., Garnier, S., & Pizzi, A. (2007). Fluorinated polyether additives to improve the performance of urea–formaldehyde adhesives for wood panels. *Journal of Applied Polymer Science*, 106(3), 1683–1688. https://doi.org/10.1002/app.26749. Link.

216 GO Lab. (2019). *Wood Fiber Insulation, Manufactured in America*. GO Lab. https://golab.us/. Link.

217 North State Journal. (2018, February 16). *Solar panels could be a source of GenX and other perfluorinated contaminants*. The North State Journal. https://nsjonline.com/article/2018/02/solar-panels-could-be-a-source-of-genx-and-other-perflourinated-contaminants/. Link.

218 Arcella, V., Merlo, L., Pieri, R., Toniolo, P., Triulzi, F., & Apostolo, M. (2014). Fluoropolymers for Sustainable Energy. In D. Smith, S. Iacono, & S. Iyer (Eds.), Handbook of Fluoropolymer Science and Technology (pp. 393–412). *Wiley Online Library*. https://doi.org/10.1002/9781118850220. Link.

219 Daikin. (2012). *Business Review: Daikin Fluorochemical Products*. In Chemwinfo. http://www.chemwinfo.com/private_folder/Uploadfiles2015_Feb/Daikin_Brochures_Chem_Biz.pdf. Link.

220 AiT Technology. (2015). *Transparent Encapsulating PVDF Front Sheet - AI Technology, Inc.* AiT Technology. https://www.aitechnology.com/products/solar/transparent-pvdf-encapsulating-front-sheet/?s=. Link.

221 Terreau, C., De, J., & Jenkins, S. (2014). *Encapsulation of solar cells* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/80/c1/43/c47454f302f6d6/US8847063.pdf. Link.

222 Daikin. (2020a). *Chemical Products UNIDYNE Repellents and Surface Modifiers Daikin America*. Daikin America. https://daikin-america.com/surface-modification-technology/#zeff. Link.

223 Daikin. (2020b). *Renewable Green Energy Zero-Energy Fluoropolymers*. Daikin America. https://daikin-america.com/renewable-energy/. Link.

224 AGC Chemicals Company. (2020a). *LUMIFLON® FEVE Resins*. AGC Chemicals. https://www.agcchem.com/products/specialty-materials/lumiflon-fluoropolymer-resins/. Link.

225 Endura Coatings. (2020). *Coatings for the Energy Industry*. Endura Coatings. https://www.enduracoatings.com/energy.html. Link.

226 DuPont. (2011). *DuPont Frontsheet Material*. In Fluorogistx. https://fluorogistx.com/wp-content/uploads/2015/10/Teflon-for-PV.pdf. Link.

227 3M. (2015b). *3M™ Scotchshield™ Backsheet Films for PV Modules*. In 3M (pp. 1–8). https://multimedia.3m.com/mws/media/1128326O/3m-scotchshield-solar-backsheet-film.pdf. Link.

228 Perkins, A. N., InayatHussain, Salmaan H, Deziel, N. C., Johnson, C. H., Ferguson, S. S., GarciaMilian, R., Thompson, D. C., & Vasiliou, V. (2019). Evaluation of potential carcinogenicity of organic chemicals in synthetic turf crumb rubber. *Environmental Research*, 169, 163–172. https://doi.org/10.1016/j.envres.2018.10.018. Link.

229 New York Department of Health. (2018). *Information About Crumb-Rubber Infilled Synthetic Turf Athletic Fields*. In New York Department of Health. https://www.health.ny.gov/environmental/outdoors/synthetic_turf/crumb-rubber_infilled/docs/fact_sheet.pdf. Link.

230 Lerner, S. (2019). Toxic PFAS Chemicals Found in Artificial Turf. The Intercept. https://theintercept.com/2019/10/08/pfas-chemicals-artificial-turf-soccer/. Link.

231 PEER. (2019). *Toxic Forever Chemicals Infest Artificial Turf*. PEER. https://www.peer.org/toxic-forever-chemicals-infest-artificial-turf/. Link.

232 PlasticsToday. (2003). *Process Aids Give Pe A High-performance Punch*. PlasticsToday. https://www.plasticstoday.com/process-aids-give-pe-high-performance-punch. Link.

233 Guo, Z., Krebs, K., & Roache, N. (2009). *Perfluorocarboxylic Acid Content in 116 Articles of Commerce*. In the United States Environmental Protection Agency. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=206124. Link.

234 Ecology Center, Changing Markets Foundation, & Gaia. (2018). *Testing Carpets for Toxics*. In Ecology Center - Healthy Stuff. https://www.ecocenter.org/healthy-stuff/reports/carpet-2018. Link.

235 Kulikov, O. (2005). Novel processing aids for extrusion of polyethylene. *Journal of Vinyl and Additive Technology*, 11(3), 127–131. https://doi.org/10.1002/vnl.20048. Link.

236 Wu, Q. (2018). *Thermoplastic Cellulosic Fiber Granules Useful as Infill Materials for Artificial Turf* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/7e/31/dc/8480d531d004dc/US20180179711A1.pdf. Link.

237 Tetrault, C. (2017). *Method for cooling of synthetic turf* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/a7/f2/d0/7bf74daf4990c9/US9540777.pdf. Link.

238 Dolce, M., Cardone, D., & Croatto, F. (2005). *Frictional behavior of steel PTFE interfaces for seismic isolation*. Bulletin of Earthquake Engineering, 3(1), 75–99. https://doi.org/10.1007/s10518-005-0187-9. Link.

239 Sweet, C. (2016). *Constructing a haven for care, healing*. San Francisco Chronicle. https://zuckerbergsanfranciscogeneral.org/wp-content/uploads/2017/05/SF-General-Final-Chronicle-Tab.pdf. Link.

240 Dynamic Isolation Systems. (2019). *Products - Sliding Isolators*. Dynamic Isolation Systems. http://www.dis-inc.com/products.html. Link.

241 FDOT. (2018). *Bridge Maintenance Course Series Reference Manual i*. In Florida Department of Transportation. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/str/bi/reference-manual/chapter-12-special-superstructure-elements.pdf?sfvrsn=c0682630_0. Link.

242 Steelman, J. S., Fahnestock, L. A., Hajjar, J. F., & LaFave, J. M. (2016). Performance of non seismic PTFE sliding bearings when subjected to seismic demands. *Journal of Bridge Engineering*, 21(1), 04015028. https://doi.org/10.1061/(ASCE)BE.1943-5592.0000777. Link.

243 Mohan, A., & Krishnankutty, Sowmya V. (2017). *Bridge Bearings–a Review*. Bridges, 4(01). e-ISSN: 2395 -0056.

244 Caltrans. (1994). *Bridge Bearings*. In California Department of Transportation. https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/memotodesigner/7-1-a11y.pdf. Link.

245 Caltrans. (2018). *Standard Specifications*. In California Department of Transportation. http://ppmoe.dot.ca.gov/hq/esc/oe/construction_contract_standards/std_specs/2018_StdSpecs/2018_StdSpecs.pdf. Link.

246 Caltrans. (2019). *Seismic Design Criteria: Version 2.0*. In California Department of Transportation. https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/seismicdesigncriteria-sdc/sdc20april2019final.pdf. Link.

247 Ingelido, A. M., Abballe, A., Gemma, S., Dellatte, E., Iacovella, N., De Angelis, Giovanna, Marra, V., Russo, F., Vazzoler, M., & Testai, E. (2020). Serum concentrations of perfluorinated alkyl substances in farmers living in areas affected by water contamination in the Veneto Region (Northern Italy). *Environment International*, 136, 105435. https://doi.org/10.1016/j.envint.2019.105435. Link.

248 Yao, J., Pan, Y., Sheng, N., Su, Z., Guo, Y., Wang, J., & Dai, J. (2020). Novel Perfluoroalkyl Ether Carboxylic Acids (PFECAs) and Sulfonic Acids (PFESAs): Occurrence and Association with Serum Biochemical Parameters in Residents Living Near a Fluorochemical Plant in China. *Environmental Science & Technology*, 54(21), 13389–13398. https://doi.org/10.1021/acs.est.0c02888. Link.

249 Young, A. S., Hauser, R., James-Todd, T. M., Coull, B. A., Zhu, H., Kannan, K., ... & Allen, J. G. (2020). Impact of “healthier” materials interventions on dust concentrations of per-and polyfluoroalkyl substances, polybrominated diphenyl ethers, and organophosphate esters. *Environment International*, 106151. https://doi.org/10.1016/j.envint.2020.106151. Link.

250 Weiss-Tisman, H. (2018). *Search For PFAS Contamination Continues In Vt., As More Instances Detected Around US*. VPR. https://www.vpr.org/post/search-pfas-contamination-continues-vt-more-instances-detected-around-us#stream/0. Link.

251 Houtz, E. F., & Sedlak, D. L. (2012). Oxidative conversion as a means of detecting precursors to perfluoroalkyl acids in urban runoff. *Environmental Science & Technology*, 46(17), 9342–9349. https://doi.org/10.1021/es302274g. Link.

252 Fudemoto, H., Harada, T., Gao, T., & Honjo, A. (2017). *Tire* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/db/a6/19/8cc8fa0560e29e/US9770949.pdf. Link.

253 Lechtenboehmer, A., Schmitz, F., Agostini, G., & Weydert, M. (2009). *Pneumatic tire containing a silica pretreated with a fluorinated silane* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/33/c5/35/aa999945de86da/US7514494.pdf. Link.

254 Yano, M., Ota, D., & Okutsu, S. (2013). *Fluororubber composition and bladder for tire fabrication* (USPTO Patent). Google Patents. https://patentimages.storage.googleapis.com/f0/99/70/3ebefad45dd41b/US20130225758A1.pdf. Link.

255 Solo-Gabriele, H. M., Jones, A. S., Lindstrom, A. B., & Lang, J. R. (2020). *Waste type, incineration, and aeration are associated with per and polyfluoroalkyl levels in landfill leachates.* Waste Management, 107, 191–200. https://doi.org/10.1016/j.wasman.2020.03.034. Link.

256 CalRecycle. (2020). *Asphalt Roofing Shingles Recycling: Introduction*. CalRecycle. https://www.calrecycle.ca.gov/condemo/shingles. Link.

257 Marks, V., & Petermeier, G. (1997). *Let Me Shingle Your Roadway*. In Iowa State Government (pp. 1–19). http://publications.iowa.gov/19901/1/IADOT_hr_2079interim_Let_Me_Shingle_Your_Roadway_1997.pdf. Link.

258 Sengoz, B., & Topal, A. (2005). Use of asphalt roofing shingle waste in HMA. *Construction and Building Materials*, 19(5), 337–346. https://doi.org/10.1016/j.conbuildmat.2004.08.005. Link.

259 Watson, D. E., Johnson, A., & Sharma, Hem R. (1998). *Georgia's experience with recycled roofing shingles in asphaltic concrete*. Transportation Research Record, 1638(1), 129–133. https://doi.org/10.3141/1638-15. Link.

260 Environmental Protection Agency. (2020). *PFAS Master List of PFAS Substances* (Version 2). CompTox. https://comptox.epa.gov/dashboard/chemical_lists/pfasmaster. Link.

261 Kwiatkowski, C., Andrews, D., Birnbaum, L., Bruton, T., DeWitt, J., Knappe, D., Maffini, M., Miller, M., Pelch, K., Reade, A., Soehl, A., Trier, X., Venier, M., Wagner, C., Wang, Z., & Blum, A. (2020). The Scientific Basis for Managing PFAS as a Chemical Class. *Environmental Science & Technology Letters*, 1–24. https://pubs.acs.org/doi/pdf/10.1021/acs.estlett.0c00255. Link.

262 Henry, B. J., Carlin, J. P., Hammerschmidt, J. A., Buck, R. C., William, B. L., Fiedler, H., Seed, J., & Hernandez, O. (2018). A critical review of the application of polymers of low concern and regulatory criteria to fluoropolymers. *Integrated Environmental Assessment and Management*, 14(3), 316–334. https://doi.org/10.1002/ieam.4035. Link.

263 Bergmann, M., Wirzberger, V., Krumpen, T., Lorenz, C., Primpke, S., Tekman, Mine B, & Gerdts, G. (2017). High quantities of microplastic in Arctic deep-sea sediments from the HAUSGARTEN observatory. *Environmental Science & Technology*, 51(19), 11000–11010. https://doi.org/10.1021/acs.est.7b03331. Link.

264 Zhao, S., Danley, M., Evan, W. J., Li, D., & Mincer, T. J. (2017). An approach for extraction, characterization and quantitation of microplastic in natural marine snow using Raman microscopy. *Analytical Methods*, 9(9), 1470–1478. https://doi.org/10.1039/C6AY02302A. Link.

265 ChemFORWARD. (2021). *Change is Our Priority*. ChemFORWARD. https://www.chemforward.org/about. Link.

266 GreenScreen®. (2018). *GreenScreen® Method*. GreenScreen® for Safer Chemicals; GreenScreen Chemicals. https://www.greenscreenchemicals.org/learn/full-greenscreen-method. Link.

APPENDIX A

PFAS in Building Materials Identified in Transparency Labels

Notes

1. Active HPDs and Declare labels used to populate this table were accessed online in November of 2020.

2. Building products with Declare labels require greater than 99% public ingredient disclosure and CASRNs are screened against the Living Building Challenge (LBC) Red List and its candidate list of substances identified as Priority for Red List Inclusion (Priority). Priority substances do not impact program compliance, but do flag on Declare labels in light orange. In January 2021, all PFAS/PFCs not already on the LBC Red List were identified by ILFI as Priority and will therefore flag on Declare labels as manufacturers renew their labels annually and ingredients are screened against the latest lists. The next additions of PFAS/PFCs to the LBC Red List will be published in January 2022.

3. Definitions

Category	The building material group as designated in this report.
Label	Either an HPD or Declare label.
HPD	The Health Product Declaration Open Standard is a standard specification for the accurate, reliable and consistent reporting of product contents and associated health information, for products used in the built environment. Learn more about HPDs at https://www.hpd-collaborative.org/.
Declare	Declare is an ingredients label for building products paired with an online database of healthy materials for building project specifications. Learn more about Declare at https://living-future.org/contact-us/faq/#declare.
Manufacturer	Identifies the business or producer of the building material that submitted their product to the label.
Product	The identifier that is given by the manufacturer and is listed on the label.
PFAS	Chemical name of the PFAS disclosed on the label.
CASRN	A 'CASRN or CAS Registry Number' is the unique chemical identifier assigned to a compound by the American Chemical Society. Learn more about CASRN at https://www.cas.org/support/documentation/chemical-substances.
Component/Function	As reported on the label, the component/function is the operative reason for applying the PFAS to the product.
% Composition	As reported on the label, % composition is the concentration of PFAS in the product.

Appendix A -- PFAS in Building Materials Identified in Eco-Labels

Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Carpets & Rugs	Declare Label	Milliken	B2 Manaaki Broadloom Carpet	Fluoroalkyl acrylate copolymer	1188515-72-1	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Broadloom Carpet	Fluoroalkyl acrylate copolymer	1188515-72-1		Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Comfort Carpet Tile - Aus	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and tetrafluoroethene	25190-89-0	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Comfort Carpet Tile - Cn	Fluoroalkyl acrylate copolymer	1188515-72-1	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Comfort Plus Carpet Tile - Aus	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and tetrafluoroethene	25190-89-0	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Comfort Plus Carpet Tile - Cn	Fluoroalkyl acrylate copolymer	1188515-72-1	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Function Carpet Tile - Aus	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and tetrafluoroethene	25190-89-0	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Function Carpet Tile - Cn	Fluoroalkyl acrylate copolymer	1188515-72-1	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac Function Carpet Tile - Uk	Polymer of 2-[methyl[(nonafluorobutyl) sulpho-nyl]amino]ethyl acrylate	67584-55-8	Additive	Undisclosed
Carpets & Rugs	Declare Label	Milliken	Wellbac™ Comfort Plus - Uk	2-propenoic acid, 2-[methyl[(1,1,2,2,3,3,4,4,4-nonafluorobutyl)sulfonyl]amino]ethyl ester	67584-55-8	Undisclosed	Undisclosed
Coatings	Declare Label	Assa Abloy	Hes 1006 Series Strike	Polytetrafluoroethylene	9002-84-0	Wire: 4 wire pigtail	Undisclosed
Coatings	Declare Label	Assa Abloy	Hes 9600 Series Electric Strike	Polytetrafluoroethylene	9002-84-0	Wire: 4 wire pigtail	Undisclosed
Coatings	Declare Label	Assa Abloy	Norton 6000 Door Operator	Polytetrafluoroethylene	9002-84-0	Ingredient	Undisclosed
Coatings	Declare Label	Imperial Paints, Llc	Ecos Woodshield Interior Stain	Poly(oxy-1,2-ethanediyl),_-hydro-_-hydroxy-, ether with_-fluoro-_-(2-hydroxyethyl)poly(difluoromethylene) (1:1)	65545-80-4	Wetting agent	Undisclosed
Coatings	Declare Label	Industrial Louvers, Inc.	Aluminum Extruded Louver With Fluropon Pure Finish	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Undisclosed	Undisclosed
Coatings	Declare Label	Industrial Louvers, Inc.	Aluminum Extruded Louver With Fluropon Pure Finish	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Undisclosed	Undisclosed
Coatings	Declare Label	Industrial Louvers, Inc.	Custom Aluminum Sunshades With Fluropon Pure Kynar Finish	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Undisclosed	Undisclosed
Coatings	Declare Label	Kawneer Company, Inc.	190/350/500 Standard Entrances	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene	9011-17-0	Thermal & weathering	Undisclosed
Coatings	Declare Label	Metal Sales Manufacturing Corp.	Fluropon Pure-coated Aluminum Panels	Ethene, 1,1-difluoro-, homopolymer	24937-79-9	Paint system as applied post bake/cure	Undisclosed
Coatings	Declare Label	Metal Sales Manufacturing Corp.	Fluropon Pure-coated Aluminum Panels	Ethene, 1,1-difluoro-, homopolymer	24937-79-9	Paint system as applied post bake/cure	Undisclosed
Coatings	Declare Label	Metal Sales Manufacturing Corp.	Fluropon Pure-coated Aluminum-zinc Alloy Coated/galvanized Steel Panels	Ethene, 1,1-difluoro-, homopolymer	24937-79-9	Paint system as applied post bake/cure [declare product val-0001]	Undisclosed
Coatings	Declare Label	Sherwin-Williams	Fluropon Pure Pvdf Coil Coating	Ethene, 1,1-difluoro-, homopolymer	24937-79-9	Coil coating (post baked and cured)	Undisclosed
Coatings	Declare Label	Sherwin-Williams	Fluropon Pure Pvdf Extrusion Coating	Ethene, 1,1-difluoro-, homopolymer	24937-79-9	Coating system as applied post bake/cure	Undisclosed
Coatings	HPD	Aluminium Products Company (alupco)	Aluminum Extruded Profiles For Architectural & Industrial Applications	Polytetrafluoroethylene	9002-84-0	Finish ingredient	0.00-1.00
Coatings	HPD	Assa Abloy	Norton 6000 Door Operator	Polytetrafluoroethylene	9002-84-0	Polymer	8.00-18.00
Coatings	HPD	Assa Abloy	Norton 6000 Door Operator	Polytetrafluoroethylene	9002-84-0	Polytetrafluoroethylene	1.00-5.00

Appendix A -- PFAS in Building Materials Identified in Eco-Labels

Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Coatings	HPD	Assa Abloy	Norton 7500 | Yale 4400 Door Closer	Polytetrafluoroethylene	9002-84-0	Polytetrafluoroethylene	1.00-5.00
Coatings	HPD	Assa Abloy	Sargent 10 Line Cylindrical Lock	Polytetrafluoroethylene	9002-84-0	Structural component	20
Coatings	HPD	Centria	Formawall Dimension Series	Pvdf paint and primer coating - see notes		Undisclosed	
Coatings	HPD	Koroseal Interior Products	Walltalkers Magrite Dry Erase Wallcovering	Perfluorosulfonic acid-ptfe copolymer	66796-30-3	Film	0.50-4.00
Coatings	HPD	Metl-span	CF - Galvalume	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Coil pre-coat component (binder)	0.00-0.08
Coatings	HPD	Metl-span	CF - Galvalume	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Coil pre-coat component (binder)	0.00-0.08
Coatings	HPD	National Aluminium Products Company Saog	Extruded Aluminum	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Powder coating	0.00-2.00
Coatings	HPD	National Guard Products	Continuous Hinge	Polytetrafluoroethylene	9002-84-0	Hinges	0.00-1.00
Coatings	HPD	PPG Architectural Finishes	PPG Duranar® Pvdf Extrusion Coatings	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Binder	30.00-40.00
Coatings	HPD	Qmi Building Metal Products Manufacturing Llc	Steel Door	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Door coating	1.5
Coatings	HPD	Sherwin-Williams	Fluropon Pure - Coil	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Polymer	0.10-2.00
Coatings	HPD	Sherwin-Williams	Fluropon Pure - Extrusion	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Polymer	29.67-36.27
Coatings	HPD	Tnemec Company Inc.	Series 1070V Fluoronar	Fluoropolymer	Undisclosed	Binder	10.0000 - 30.0000
Coatings	HPD	Tnemec Company Inc.	Series 1071V Fluoronar	Fluoropolymer	Undisclosed	Resin	10.0000 - 30.0000
Coatings	HPD	Tnemec Company Inc.	Series V700 LOW VOC HydroFlon	Fluoropolymer	Undisclosed	Binder	10.0000 - 30.0000
Coatings	HPD	United Metal Coating Llc	Pre-painted Galvanized Steel Coils For Roofing & Claddings, Interior Ceilings	Polyvinylidene fluoride	24937-79-9	Polymer species	0.00-3.14
Fabric	Declare Label	Luum Textiles	Polyester & Polyester Compound Fabrics	Fluoroalkyl methacrylate copolymer, pfoa-free stain repellent	92265-81-1	Undisclosed	Undisclosed
Fabric	Declare Label	Mecho	Mecho®/5, Mecho®/5x, And Urbanshade™ Manual Hardware Systems	Polytetrafluoroethylene	9002-84-0	Undisclosed	Undisclosed
Fabric	HPD	Architex International	Coral	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	Architex International	Crest	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1

Appendix A -- PFAS in Building Materials Identified in Eco-Labels

Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Fabric	HPD	Architex International	Cutting Edge	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	Architex International	Flourish	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	Architex International	Open Water	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	Architex International	Wade	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	Architex International	Wind Wave	Fluorocarbon based stain repellent	Not Registered	Stain repellent	1
Fabric	HPD	C.F. Stinson, LLC	ComeBack	Poly(choline Chloride Methacrylate-co-2-ethoxyethyl Acrylate-co-glycidyl Methacrylate-co-n-methylperfluorooctanesulfonamidoethyl Acrylate)	92265-81-1	Water and oil repellent treatment	0.15-0.23
Fabric	HPD	Mermet Corporation	Avila Daylight™	Fluoropolymer	Undisclosed	Antistain	.0500-0.1000
Fabric	HPD	Pallas Textiles	Adele	Fluorocarbon 77 (primary casrn is 335-36-4)	12627-87-1	Antistain	0.10-0.10
Fabric	HPD	Pallas Textiles	Athalie	Fluorocarbon stain repellant		Antistain	1.00-3.00
Fabric	HPD	Pallas Textiles	Curve	Fluorocarbon 77 (primary casrn is 335-36-4)	12627-87-1	Antistain	1.00-3.00
Fabric	HPD	Pallas Textiles	Icon	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Polymer species	0.11-0.11
Fabric	HPD	Pallas Textiles	Majolica	Fluorocarbon fc 70 (primary casrn is 338-84-1)	72433-08-0	Antistain	0.10-0.10
Fabric	HPD	Pallas Textiles	Urbanized	Fluorocarbon 77 (primary casrn is 335-36-4)	12627-87-1	Antistain	0.10-0.10
Fabric	HPD	Saint Gobain	Certainteed Decoustics Lightframe	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with ethene, 1,1,1,2,2,3,3-heptafluoro3-[(trifluoroethenyl)oxy]propane and tetrafluoroethene	74499-71-1	Diffusor component	100
Fabric	HPD	Saint Gobain	Certainteed Decoustics Lightframe	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-9	Fabric component	95.00-100.00
Fabric	HPD	Vescom America Inc.	Aidan (101315)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Alpha (101824)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Alpine (100579)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Alpine (101984)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Aurora (101335)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Basis (101592)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Black Out Curtains	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00

Appendix A -- PFAS in Building Materials Identified in Eco-Labels							
Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Fabric	HPD	Vescom America Inc.	Brayer Flower (101825f-t1)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Checkmate (102122)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Composition Mist	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Coppice (100311)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Etch (102289q)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Exeter (100790)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Facet (100691)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Full Turn (102242f-t1)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Glaze (102296s)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Hella's Tiles (102296s)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	High Line (101982)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Lift (101512)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Lucent (100116c)	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric	HPD	Vescom America Inc.	Marquisette (101782)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Masami (101396)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Melody (101866)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Metamorphosis (101593)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Multiply (s-102439e)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	New Sunrise With Raffia (s-102403b)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Nuevo Linen (100623)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Ophelia (101569)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Overlapping Stripe (102230)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00

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Fabric	HPD	Vescom America Inc.	Overpass (101441)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Pandemonium (s-101981d)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Radiance (100088e-t2)	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric	HPD	Vescom America Inc.	Radiator (102176)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Rappel (510100)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Respite (100065a)	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric	HPD	Vescom America Inc.	Rib Stripe (s-102289q)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Rolling Stones (250010)	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric	HPD	Vescom America Inc.	Spellbound (100626)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Spinnaker (101962)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Static (102043)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Fabric	HPD	Vescom America Inc.	Stratus (100310)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Vanish (100884p-t1)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Venice (102427a)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Voltage (101093r-t1)	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Willow Talk (250006)	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric	HPD	Vescom America Inc.	102459s-t1	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric	HPD	Vescom America Inc.	Ritual (101849)	Fluorocarbon stain repellent		Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Solange (100926)	Fluorocarbon stain repellent		Stain repellent	Undisclosed
Fabric	HPD	Vescom America Inc.	Vera (101474)	Fluorocarbon stain repellent		Stain repellent	Undisclosed
Fabric - Furniture	HPD	C.F. Stinson, LLC	Full Turn	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric - Furniture	HPD	C.F. Stinson, LLC	Lucent	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric - Furniture	HPD	C.F. Stinson, LLC	Multiply	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00

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Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Fabric - Furniture	HPD	C.F. Stinson, LLC	Radiance	Low fluorocarbon nanoparticle based water and stain repellent	Undisclosed	Stain repellent/antimicrobial	1.00-3.00
Fabric - Furniture	HPD	C.F. Stinson, LLC	Sprint	Fluoroalkyl Acrylate Copolymer	Undisclosed	Top Coat	0.11-0.11
Fabric - Furniture	HPD	C.F. Stinson, LLC	Vanish	Fluorocarbon stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric - Furniture	HPD	Designtex	Birdseye	C6 perfluorinated surfactant	141607-32-1	Stain repellent	0.50-1.00
Fabric - Furniture	HPD	Designtex	Gamut	Perfluorinated alkyl compounds (PFAS), short-chain	Not registered	Stain repellent	0.50-1.00
Fabric - Furniture	HPD	Designtex	Jacquard I	C6 perfluorinated surfactant	141607-32-1	Stain repellent	0.25-0.25
Fabric - Furniture	HPD	Designtex	Jacquard Ii	C6 perfluorinated surfactant	141607-32-1	Stain repellent	0.25-0.25
Fabric - Furniture	HPD	Designtex	Measure	Perfluoro compounds, C5-18	86508-42-1	Stain repellent	0.50-1.00
Fabric - Furniture	HPD	Designtex	Score	Perfluorinated alkyl compounds (PFAS), short-chain	Not registered	Stain repellent	1.00-2.00
Fabric - Furniture	HPD	Designtex	Tweed Multi	Perfluorinated alkyl compounds (PFAS), short-chain	Not registered	Stain repellent	0.10-0.50
Fabric - Furniture	HPD	Designtex	Ulster Upholstery	Perfluorinated alkyl compounds (PFAS), short-chain	Not registered	Stain repellent	0.10-0.50
Fabric - Furniture	HPD	Designtex	Union Cloth	Per and polyfluorinated alkyl substances (PFAS) / perfluorinated compounds (PFC)	Not registered	Water repellent	0.50-1.00
Fabric - Furniture	HPD	Designtex	Woolish	C6 perfluorinated surfactant	141607-32-1	Stain repellent	0.25-0.25
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Atmosphere	Perfluorocarbons, short-chain	Not registered	Stain repellent	0.10-0.20
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Beach Blanket	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Bellhop	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Concierge	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Linen Looks - Bowie Basket	Stain repellent	Undisclosed	Stain repellent	1.00-3.00
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Play Ball	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Room Service	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Sunbrella Contract By Arccom - Bali	Perfluoroalkyl and polyfluoroalkyl substances (PFAS)	Not registered	Non-pfoa water repellent	0.00-0.75
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Sunbrella Contract By Arccom - Crescendo	Perfluoroalkyl and polyfluoroalkyl substances (PFAS)	Not registered	Non-pfoa water repellent	0.00-0.75

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Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Sunbrella Contract By Arccom - Sonata Stripe	Perfluoroalkyl and polyfluoroalkyl substances (PFAS)	Not registered	Non-pfoa water repellent	0.00-0.75
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Sunbrella Contract By Arccom - Staccato	Perfluoroalkyl and polyfluoroalkyl substances (PFAS)	Not registered	Non-pfoa water repellent	0.00-0.75
Fabric - Furniture	HPD	Glen Raven Custom Fabrics, LLC - Sunbury Division	Added Amenities	Fluorocarbon stain repellent	Undisclosed	Stain repellent	100
Fabric - Furniture	HPD	Mermet Corporation	Greenscreen® Reflect™	Fluorocarbon polymers	Not registered	Corrosion resistance	0.30-0.60
Fabric - Furniture	HPD	Mermet Sas France	Screen Nature Ultimetal	Fluorocarbon polymers	Not registered	Corrosion resistance	0.30-0.60
Fabric - Wallcovering	HPD	Dupont Specialty Products Usa, LLC	Dupont™ Tedlar™ Wallcoverings - Avant-garde Collection (alloy, Sequoia, Set In Stone)	Polyvinyl fluoride	24981-14-4	Structure component	98.50-98.50
Fabric - Wallcovering	HPD	Dupont Specialty Products Usa, LLC	Dupont™ Tedlar™ Wallcoverings - Celestial Collection (northern Lights, Orbital, Saturn, Volans)	Polyvinyl fluoride	24981-14-4	Structure component	98.50-98.50
Fabric - Wallcovering	HPD	Dupont Specialty Products Usa, LLC	Dupont™ Tedlar™ Wallcoverings - Essentials Collections	Polyvinyl fluoride	24981-14-4	Base polymer	98.5
Fabric - Wallcovering	HPD	Dupont Specialty Products Usa, LLC	Dupont™ Tedlar™ Wallcoverings - Geometrico Collection	Polyvinyl fluoride	24981-14-4	Base polymer	98.5
Fabric - Wallcovering	HPD	Dupont Specialty Products Usa, LLC	Dupont™ Tedlar™ Wallcoverings - Passport Collection (mod, Mod Linen)	Polyvinyl fluoride	24981-14-4	Structure component	98.50-98.50
Fabric - Wallcovering	HPD	E. I. Du Pont De Nemours And Company	Dupont™ Tedlar™ Wallcoverings - Passport I Collection	Polyvinyl fluoride	24981-14-4	Base polymer	98.5
Fabric - Wallcovering	HPD	J. Josephson, Inc.	Commercial Vinyl Wallcoverings	Polyvinyl fluoride	24981-14-4	Structure	2.00-2.00
Fabric - Wallcovering	HPD	J. Josephson, Inc.	P3tec	Polyvinyl fluoride	24981-14-4	Structure component	2.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Akita Wc1621	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Alias Ii Backed Wc2113b	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Alloy Backed Wc2139b	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Antares Wc1480	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Apollo Backed Wc2178b	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Archer Ii Wc2115b	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00

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Fabric - Wallcovering	HPD	Knolltextiles	Arena Wc2138	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Asterisk Ii Backed, Wc2114b	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Knolltextiles	Prague Wc1393	Fluorocarbon stain repellent and antimicrobial	Undisclosed	Stain repellent	1.00-2.00
Fabric - Wallcovering	HPD	Luna Textiles	Alexander	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Amuse	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Bedrock	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Betwixt	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Boomerang	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Charm	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Delight	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Harmonize	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Motif	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Scintillate	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Signal	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Stacking Chairs	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Luna Textiles	Synthesis	Perfluoroalkyl acrylate-, copolymer	90451-86-8	Substance composition	100.00-100.00
Fabric - Wallcovering	HPD	Valdese Weavers	F-0254112 (formation)	Fluorocarbon stain repellent	Undisclosed	Antistain	1.00-3.00
Lighting	Declare Label	Humanscale	Vessel	FEP	25067-11-2	Ingredient	Undisclosed
Lighting	Declare Label	Humanscale	Vessel	FEP	25067-11-2	Ingredient	Undisclosed
Lighting	HPD	Humanscale	Nova	1-hexene, 3,3,4,4,5,5,6,6,6-nonafluoro-, polymer with ethene and tetrafluoroethene	68258-85-5	Base resin	0.32-0.33
Lighting	HPD	Humanscale	Nova	Polytetrafluoroethylene	9002-84-0	Base resin	33.80-33.90

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Roofing	Declare Label	GAF	Resilient Red List Free Adhered Tpo Roofing System	1,1,1,2-tetrafluoroethane	811-97-2	Adhesive	Undisclosed
Sealants	HPD	Custom Building Products	Aqua Mix® Penetrating Sealer	Ethanol, 2,2'-iminobis-, compd. With _-fluoro-_-[2-(phosphonooxy)ethyl]poly(difluoromethylene) (1:1)	65530-74-7	Stain repellent	0.00-0.10
Sealants	HPD	Custom Building Products	Aqua Mix® Penetrating Sealer	Ethanol, 2,2'-iminobis-, compd. With _,_'-[phosphinicobis(oxy-2,1- ethanediyl)]bis[_-fluoropoly (difluoromethylene)] (1:1)	65530-64-5	Stain repellent	0.00-0.10
Sealants	HPD	Custom Building Products	Tilelab® Grout & Tile Sealer	Ethanol, 2,2'-iminobis-, compd. With _-fluoro-_-[2-(phosphonooxy)ethyl]poly(difluoromethylene) (1:1)	65530-74-7	Stain repellent	0.00-0.10
Sealants	HPD	Custom Building Products	Tilelab® Grout & Tile Sealer	Ethanol, 2,2'-iminobis-, compd. With _,_'-[phosphinicobis(oxy-2,1- ethanediyl)]bis[_-fluoropoly (difluoromethylene)] (1:1)	65530-64-5	Stain repellent	0.00-0.10
Sealants	HPD	Custom Building Products	Tilelab® Grout Sealer	Ethanol, 2,2'-iminobis-, compd. With _-fluoro-_-[2-(phosphonooxy)ethyl]poly(difluoromethylene) (1:1)	65530-74-7	Water resistance	0.00-0.10
Sealants	HPD	Custom Building Products	Tilelab® Grout Sealer	Ethanol, 2,2'-iminobis-, compd. With _,_'-[phosphinicobis(oxy2,1-ethanediyl)]bis[_-fluoropoly (difluoromethylene)] (1:1)	65530-64-5	Water resistance	0.00-0.10
Solar	Declare Label	Maxeon Solar Technologies, Ltd.	Sunpower® Maxeon® 2 & 3 Panels	Polyvinylidene fluoride	24937-79-9	Backsheet	Undisclosed
Solar	Declare Label	Maxeon Solar Technologies, Ltd.	Sunpower® Maxeon® 5 Panels	Polyvinylidene fluoride	24937-79-10	Backsheet	Undisclosed
Wire & Cable	Declare Label	Superior Essex	Cat 5e With Fep Jacket	Fluorinated ethylene propylene	25067-11-2	FEP jacket, FEP, color chip	Undisclosed
Wire & Cable	Declare Label	Superior Essex	Category 6 With Fep Jacket - Cmp	Fluorinated ethylene propylene	25067-11-3	FEP jacket, FEP, color chip	Undisclosed
Wire & Cable	Declare Label	Superior Essex	Category 6a U/ftp (stp) With Fep Jacket	Fluorinated ethylene propylene	25067-11-2	FEP jacket, FEP, color chip	Undisclosed
Wire & Cable	HPD	Legrand	Wattstopper - Pre-Terminated Cables (Plenum Rated)	1-Propene, 1,1,2,3,3,3-Hexafluoro-, Polymer with Tetrafluoroethene	25067-11-2	Insulation	99.61
Wire & Cable	HPD	Prysmian Group	GenSPEED 10,000 Category 6A U/FTP (STP) Plenum Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Wire & Cable	HPD	Prysmian Group	GenSPEED 5000 Category 5E CMP , GenSPEED 5350 Enhanced Category 5E CMP, GenSPEED 5500 Premium Category 5E CMP	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulator	95.00-100.00
Wire & Cable	HPD	Prysmian Group	GenSPEED 5000 Category 5e F/UTP (ScTP) Plenum Cable	1. 1-Propene, 1,1,2,3,3,3-Hexafluoro-, Polymer With Id: 25067-11-2 Tetrafluoroethene 2. 1-Propene, 1,1,2,3,3,3-Hexafluoro-, Polymer with Tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95-100 2. 0.0-100
Wire & Cable	HPD	Prysmian Group	GenSPEED® 10 MTP™ Category 6A CMR Cable	1. Hexafluoropropene tetrafluoroethylene polymer 2. Hexafluoropropene tetrafluoroethylene polymer 3. Hexafluoropropene tetrafluoroethylene polymer 4. 1-Propene, 1,1,2,3,3,3,-hexafluoro-, polymer with Tetrafluoroethene	1. 25067-11-2 2. 25067-11-2 3. 25067-11-2 4. 25067-11-2	1. Carrier 2. Carrier 3. Carrier 4. Insulator	1. 80.00-90.00 2. 70.00-90.00 3. 60.00-70.00
Wire & Cable	HPD	Prysmian Group	GenSPEED® 6 Category 6 CMP, GenSPEED® 6000 Enhanced Category 6 CMP, GenSPEED® 6500 Premium Category 6 CMP	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. Polytetrafluoroethylene	1. 25067-11-2 2. 9002-84-0	1. Insulator 2. Polymer species	1. 95.00-100.00 2. 0.00-0.30
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: 10gain Category 6a	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100

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Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: 10gain Category 6a	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: 10gain Xp Category 6a	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: 10gain Xp Category 6a	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 5e+ Sctp (f/utp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6 With Fep Jacket	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Jacketing	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6 With Fep Jacket	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6 With Fep Jacket	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6+ Sctp (f/utp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6+ Sctp (f/utp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6a Sctp (f/utp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6a Sctp (f/utp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6a Stp (u/ftp)	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6a U/ftp (stp) W/ Fep Jacket	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Category 6a U/ftp (stp) W/ Fep Jacket	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Jacketing	100

Appendix A -- PFAS in Building Materials Identified in Eco-Labels

Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Cobra Category 5e+	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Datagain Category 6+	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Datagain Category 6+	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Marathon Lan Category 5e	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Nextgain Category 6ex	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Nextgain Category 6ex	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Powerwise 10g 4ppoe	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Insulation	100
Wire & Cable	HPD	Superior Essex	Superior Essex 4-pair Plenum Copper Cable: Powerwise 10g 4ppoe	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Cross web separator	100
Wire & Cable	Declare Label	Vode Lighting LLC	Vode Adaptive Architectural Lighting Systems 1	Fluorinated ethylene propylene (masterbatch)	25067-11-2	Output cable, suspension cable, input cable, remote driver enclosure ground wire	Undisclosed
Wire & Cable	HPD	Prysmian Group	GenSPEED® 10 MTP™ Category 6A CMP Cable	1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	25067-11-2	Carrier	0.00-100
Wire & Cable	HPD	Prysmian Group	GenSPEED® 10 Indoor/Outdoor Plenum Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Wire & Cable	HPD	Prysmian Group	GenSPEED® 10 Category 6A CMR Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 3. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 4. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2 3. 25067-11-2 4. 25067-11-2	1. Insulator 2. Carrier 3. Carrier 4. Carrier	1. 95.00-100.00 2. 80.00-90.00 3. 70.00-80.00 4. 60.00-70.00
Wire & Cable	HPD	Prysmian Group	GenSPEED® 10 Category 6A CMP Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Wire & Cable	HPD	Prysmian Group	22AWG GenSPEED® 6 Plenum Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. Polytetrafluoroethylene 3. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 9002-84-0 3. 25067-11-2	1. Insulator 2. Undisclosed 3. Carrier	1. 95.00-100.00 2. 0.00-0.300 3. 0.00-100.00

Appendix A -- PFAS in Building Materials Identified in Eco-Labels

Category	Label	Manufacturer	Product	PFAS	CAS #	Component/ function	% Composition
Wire & Cable	HPD	Prysmian Group	GenSPEED® 6 Category 6 and GenSPEED® 10 Category 6A F/UTP (ScTP) Plenum Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Wire & Cable	HPD	Prysmian Group	GenSPEED 6 F/UTP (ScTP) and GenSPEED 10 Category 6A F/UTP (ScTP) Riser Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Wire & Cable	HPD	Prysmian Group	GenSPEED 6 F/UTP (ScTP) Riser Cable	1. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene 2. 1-propene, 1,1,2,3,3,3-hexafluoro-, polymer with tetrafluoroethene	1. 25067-11-2 2. 25067-11-2	1. Insulator 2. Carrier	1. 95.00-100.00 2. 0.00-100.00
Coatings	HPD	MOZ Designs, Inc	Corrugated Aluminum	Polyvinylidene fluoride (1,1-difluoroethene homopolymer)	24937-79-3	Binder	30.00-40.00
Sealants	HPD	Panel Rey S.A.	Midweight Ready Mix Joint Compound	Lithium Salt	29457-72-5	Impurity/Residual	Undisclosed