MILLIMAN REPORT

The “forever chemical” risk is now: An actuarial reserving study can help insurers prepare for PFAS claims and litigation

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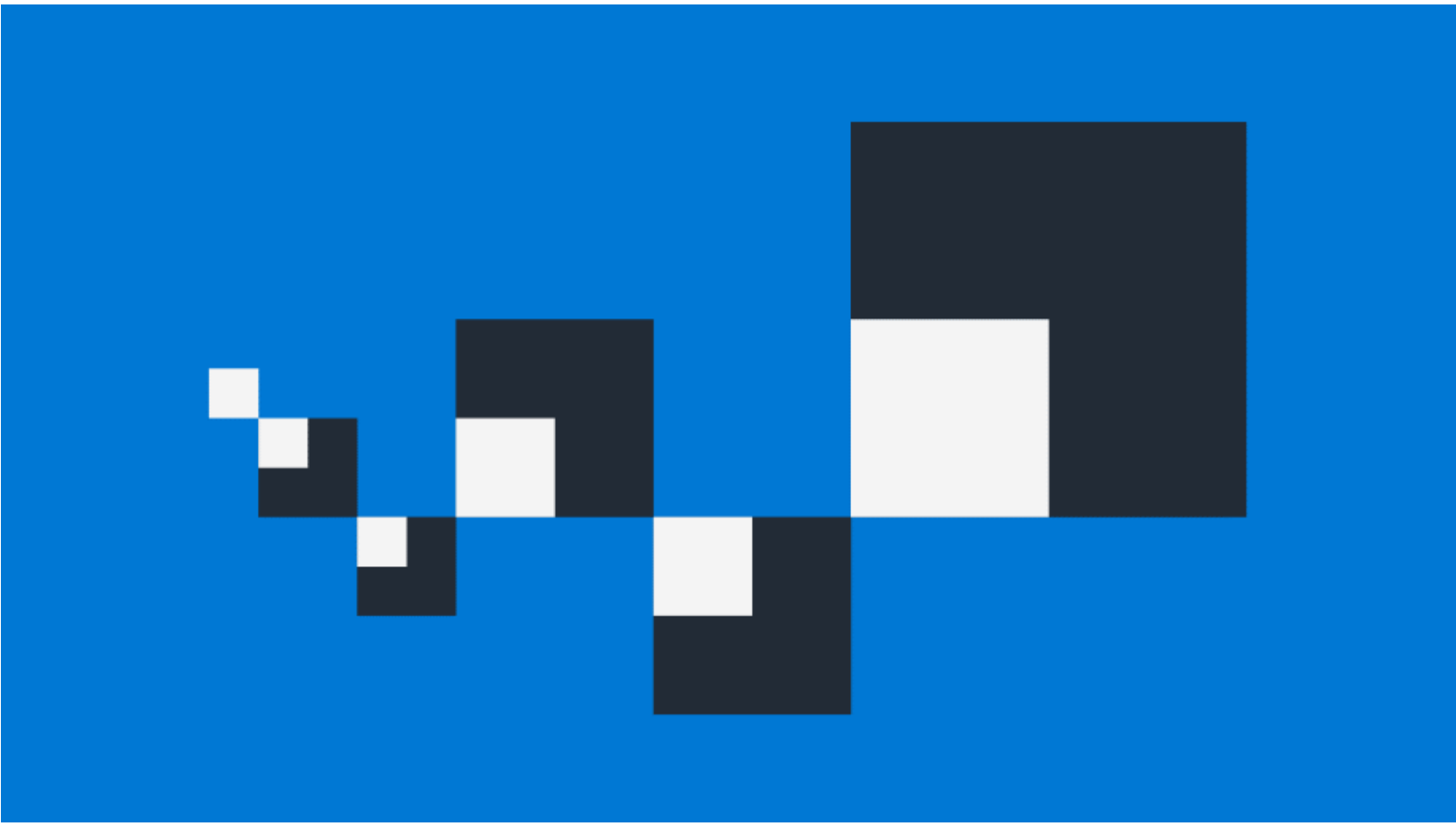

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Introduction

It is perhaps only a slight exaggeration to assert that per- and polyfluoroalkyl substances (PFAS) are everywhere. The incredibly strong carbon-fluorine bonds of these “forever” chemicals are what makes them so useful and also what allows them to travel far from their original source and resist degradation in even the most extreme conditions. PFAS have been found in polar bears and flamingos, the produce, eggs, meat, and fish we eat, cosmetics and lotions we apply to our skin, household dust we breath, water we drink, and breast milk that nourishes our infants. Indeed, virtually all people have some level of PFAS in them.

Once in the body, PFAS readily bond to blood molecules and are delivered to our organs and tissues, accumulating in cells and proteins. While the precise mechanism of harm is not fully understood, many studies have demonstrated a correlation between levels of certain PFAS in the body and adverse health effects such as fatty liver disease, testicular cancer, kidney cancer, diabetes, immune and neurological impairments, high cholesterol and hypertension, obesity, and infertility. Yet other studies find no statistical association between PFAS and certain of these diseases. Over the past 20 years, more than 10,000 peer-reviewed studies have been published investigating PFAS in the environment, routes of human exposure, and the potential for it to cause harm. Despite all these studies, however, there is still much uncertainty about the types and levels of PFAS exposure that materially elevate risks to human health.

The first lawsuit alleging harm from PFAS exposure was filed in 1999. Twenty-four years later, more than 9,800 lawsuits have been filed in 123 federal and state courts against 357 companies spanning 140 industries. A small number of companies—3M and DuPont most notably—have executed or proposed settlements totaling approximately $16.7 billion thus far, but the potential damage and number of defendants is far greater. The cost of remediating drinking water to meet federal PFAS standards could be in the hundreds of billions, thousands of bodily injury lawsuits have yet to settle, and there exists a wide range of property damage and bodily injury causes of action that are likely to gain further support as scientists continue their investigations.

Whether PFAS will be the “next asbestos” that casualty actuaries have long anticipated remains to be determined. Certainly, the plaintiffs’ bar argues that the exposures are latent and widespread and the science is convincing.

While the evidence suggests that PFAS could lead to widescale claims and potential liabilities, setting aside reserves for future PFAS claims is not as commonplace as one might assume. To date, PFAS liabilities have often been deemed inestimable, citing limited historical claims data, the evolving nature of PFAS litigation, and difficulty determining which insured accounts may be called upon to cover these liabilities. While all these points are indeed true, it does not mean that the liabilities are impossible to estimate. Instead, actuaries can address these issues head-on by drawing from historical insights of similar liabilities, working closely with other experts (e.g., claims management, legal strategists, predictive modelers), and expanding the tools used to identify sources of future claims.

Companies are beginning to take these steps to develop early PFAS reserves, but the approach has often been reactive, as litigation plays out, instead of proactively trying to determine the best estimate of the ultimate liabilities. Developing an approach to quantify PFAS reserves today will allow companies to produce an actuarially-sound reserve estimate that helps them make important business decisions and could allow them to get ahead of potential adverse development instead of continually playing catch-up in future years.

The goal of this paper is to provide essential background on the current state of PFAS litigation and discuss what reserving methodology can be utilized for companies to produce PFAS liability estimates today.

A remarkably useful class of chemicals

The first company to commercially develop perfluorooctanoic acid (PFOA) by bonding carbon and fluorine was 3M in the late 1940s. PFOA, like its many PFAS cousins, is an extraordinarily stable surfactant highly effective at repelling water and oil. While 3M did not initially develop its own downstream uses for PFOA, it instead sold the chemical to DuPont, which used it to make its blockbuster compound Teflon, the brand name for the "slipperiest substance on earth," polytetrafluoroethylene (PFTE). Then 3M went on to develop the other original PFAS compound, perfluorooctanesulfonic acid (PFOS), in the early 1950s, which wound up in its famous Scotchgard fabric protector, fire-fighting foams, and numerous other industrial and consumer products.[1]

While PFOA and PFOS were largely phased out in the United States in the 2000s, many other individual PFAS are still in commercial use today.[2] A comprehensive inventory of PFAS uses derived from regulatory databases, patents, and measurement studies by Gluge et al. (2020) identifies more than 200 distinct uses for more than 1,400 individual PFAS, spanning industries ranging from aerospace to watchmaking.[3] Some of the most well-known applications of PFAS include:

- **Textiles**. PFAS provide durable water repellency and stain resistance in clothing, shoes, carpets, upholstery, and many other textile products.
- **Personal care products**. PFAS serve a number of functions in personal care products, including making cosmetics like mascara, foundation, and lipstick resistant to smudge or smear, imparting a smooth, slick feel to hair products and lotions, preventing products from staining or becoming sticky, and stabilizing product formulations for longer shelf life.
- **Food production**. Fluoropolymers made with PFAS coat metal surfaces on food production equipment to lower friction, minimize adhesion, and prevent corrosion. Many of the same applications exist for household kitchenware, where nonstick coatings and stain resistance are in high demand.
- **Food packaging**. PFAS provide water and grease resistance to food packaging materials, making them particularly useful for fast-food wrappers, microwave popcorn bags, pizza boxes, and pet food bags.
- **Firefighting**. PFAS has been a critical ingredient in aqueous film-forming foam (AFFF), which quickly extinguishes liquid fires such as fires in oil, jet fuel, other non-water-soluble hydrocarbons, alcohols, and acetone.
- **Paints and coatings**. PFAS are added to some paints, varnishes, and coatings to enhance their protective and spreading capabilities.
- **Medical devices**. PFAS coatings reduce friction and improve clot resistance in catheters, stents, and needles and provide protein-resistance in filters, tubing, gaskets, and seals.
- **Laboratory equipment**. PFAS are commonly found in laboratory equipment because of their heat resistance, weak interaction with other substances, and low permeability.
- **Plastic production**. PFAS help with molding and extrusion of plastic products.
- **Other applications**. Other PFAS applications include ski wax, fuel cells, protective tapes and films, cable insulation, optical fiber coating, roofing, plumbing and piping, heat exchangers, semiconductor manufacturing, and chemical processing.

1 Lerner, S. (July 2018). 3M knew about the dangers of PFOA and PFOS decades ago, internal documents show. The Intercept.

2 For the technically minded, the Organisation for Economic Co-operation and Development (OECD) defined PFAS in 2021 as follows: "Fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e., with a few noted exceptions, any chemical with at least a perfluorinated methyl group (−CF3) or a perfluorinated methylene group (−CF2−) is a PFAS." See OECD (2021), Reconciling terminology of the universe of per- and polyfluoroalkyl substances: Recommendations and practical guidance, Series on Risk Management No. 61.

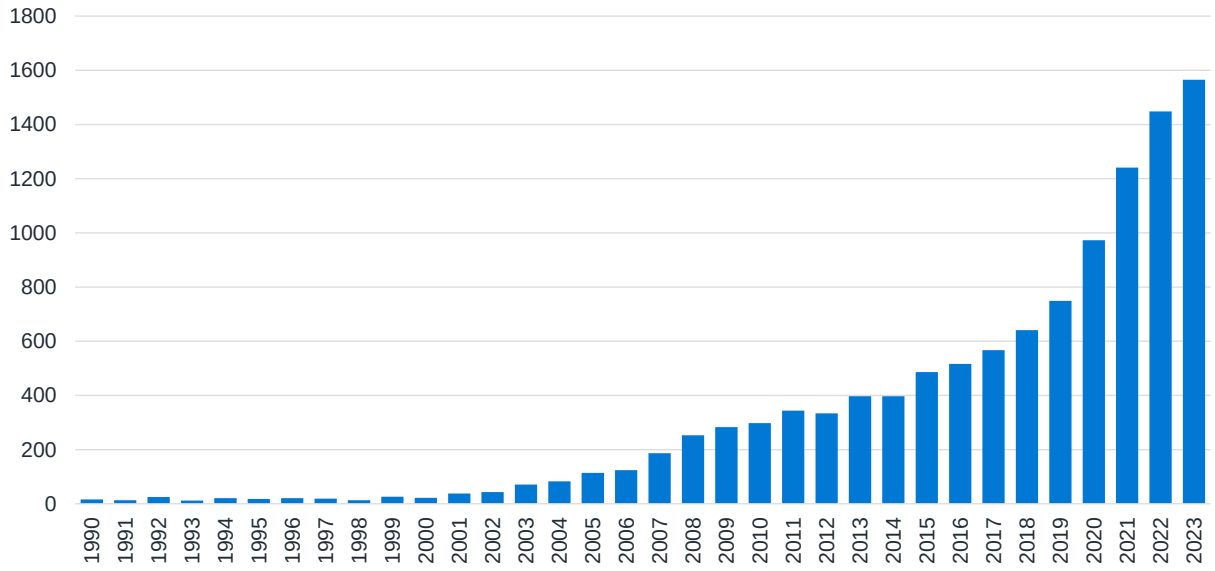
3 Gluge, J., Scheringer, M., Cousins, I., DeWitt, J., Goldenman, G., Herzke, D., Lohmann, R., Ng., C., Trier, X., & Zhanyun, W. (2020). An overview of the uses of per- and polyfluoroalkyl substances (PFAS). Environmental Science: Processes & Impacts 22.

Health concerns mount

PFAS were the subject of minimal scientific interest up until 2000, when 3M announced to the U.S. Environmental Protection Agency (EPA) that it would voluntarily phase out production of PFOS in the United States. The decision to phase out PFOS was based principally on internal research conducted by 3M showing that PFOS was very persistent in the environment and accumulated in human and animal tissue. The carbon-fluorine bonds of PFOS and all PFAS are among the strongest in organic chemistry, resisting degradation and facilitating transport. The internal research of 3M also suggested potential human health effects, although in 2000 it asserted that exposure at levels commonly measured in the environment did not pose a risk and there was little peer-reviewed published literature at that time to indicate otherwise. As the EPA investigated more, however, it became increasingly concerned about both PFOS and PFOA and, in 2006, announced the PFOA Stewardship Program, aimed at eliminating PFOA from emissions and products by 2015.[4]

By the mid-2000s, the volume of peer-reviewed research investigating the environmental and human health effects of PFAS was rapidly accelerating (see Figure 1[5]). The surge in research coincided both with the realization that PFAS could be found throughout the world in water, soil, animals, and humans and that PFAS and many other industrial chemicals were likely having a profound impact on the normal functioning of the endocrine system, the complex network of glands and organs that synthesize, secrete, and respond to hormones that regulate a host of critical biological functions and processes, including metabolism, growth, reproduction, and mood.

FIGURE 1: NUMBER OF SCIENTIFIC ARTICLES INVESTIGATING PFAS, BY YEAR



Data source: PubMed, National Library of Medicine

4 See https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program.

5 Figure 1 is generated from the National Library of Medicine's PubMed database of biomedical literature, accessed September 25, 2023. Publication counts for year-end 2023 are an estimate.

We can summarize the peer-reviewed literature on PFAS and human health with the help of the General Causation (GC) risk score, an algorithm developed by Praedicat, Inc. that measures scientific support for hypotheses of bodily injury. The GC risk score ranges between -1.0 and +1.0, where -1.0 indicates the scientific community overwhelmingly rejects a given hypothesis and +1.0 indicates it overwhelmingly accepts a given hypothesis. The score increases with number of studies, strength of measured associations, and the quality and diversity of evidence across study designs. The hypothesis that asbestos exposure causes mesothelioma, for example, has a GC risk score of 1.0.

The GC risk score is above 0.90 for the hypothesis that PFOA and PFOS exposure causes endocrine system injury. According to Praedicat's analytics, more than 120 peer-reviewed studies have tested these hypotheses in vitro, in animal models, and in humans to date; 85% of these studies support the hypothesis. This level of support suggests that in certain jurisdictions some judges may allow juries to hear evidence from experts supporting a plaintiff's allegation that their exposure to PFOA or PFOS affected the normal functioning of their endocrine system (the lack of specificity in these allegations, of course, is problematic for plaintiffs).

Hypotheses related to gestational, neonatal, or other very early life exposure to PFAS also have strong support in the scientific literature. PFAS readily cross the placenta to the developing fetus and are routinely found in cord blood and breast milk.[6] The presence of PFAS in household dust is also well documented.[7] Praedicat's GC risk score is currently 0.88 and 0.79 for PFOA and PFOS causing developmental injury, respectively. Observed developmental injuries encompass a wide range of endpoints including fetal and early life growth, bone development, metabolic functioning, cognitive and behavioral development, and thyroid function.

Evidence is also mounting that PFAS interfere with normal immune system functioning (GC risk scores of 0.61 and 0.55 for PFOA and PFOS, respectively, up sharply since 2019). A 2021 study in the Faroe Islands, for example, found that children with high levels of PFAS exposure had significantly less protection from tetanus and diphtheria vaccination.[8] Another 2021 study reported a correlation between prenatal PFAS exposure and subsequent hospitalization for infectious disease.[9] And, in 2020, researchers reported that exposure to PFAS doubled the risk of hospitalization for those infected with COVID-19.[10] The mechanism is not well understood, but researchers suspect that PFAS interfere with immune cells responsible for generating antibodies.

One of the more remarkable developments in the long legal and toxicological history of PFAS was the establishment of the C-8 Science Panel in 2004 ("C-8" refers to PFOA's eight carbon chain structure). As discussed more below, the C-8 Science Panel was the result of the historic *Leach v. DuPont* class action settlement in which DuPont agreed to fund an independent panel charged with conducting epidemiological studies in the communities surrounding its Washington Works plant in Parkersburg, West Virginia, to determine whether there was a "probable link" between PFOA exposure and 17 categories of bodily injury. Eight years later, in 2012, the panel concluded there was indeed a probable link to high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension. These findings launched the C-8 multidistrict litigation that would eventually include more than 3,700 individual lawsuits.

6 Roger, J., Bangma, J., Carberry, C., Chao, A., Grossman, J., Lu, K., Manuck, T., Sobus, J., Szilagyl, J., & Fry, R. (2020). Review of the environmental prenatal exposome and its relationship to maternal and fetal health. Reproductive Toxicology 98.

7 Hall, S., Patton, S., Petreas, M., Zgang, S., Phillips, A., Hoffman, K., & Stapleton, H. (2020). Per- and polcyfluoroalkyl substances (PFAS) in dust collected from residential homes and fire stations in North America. Environ Sci Technol 54.

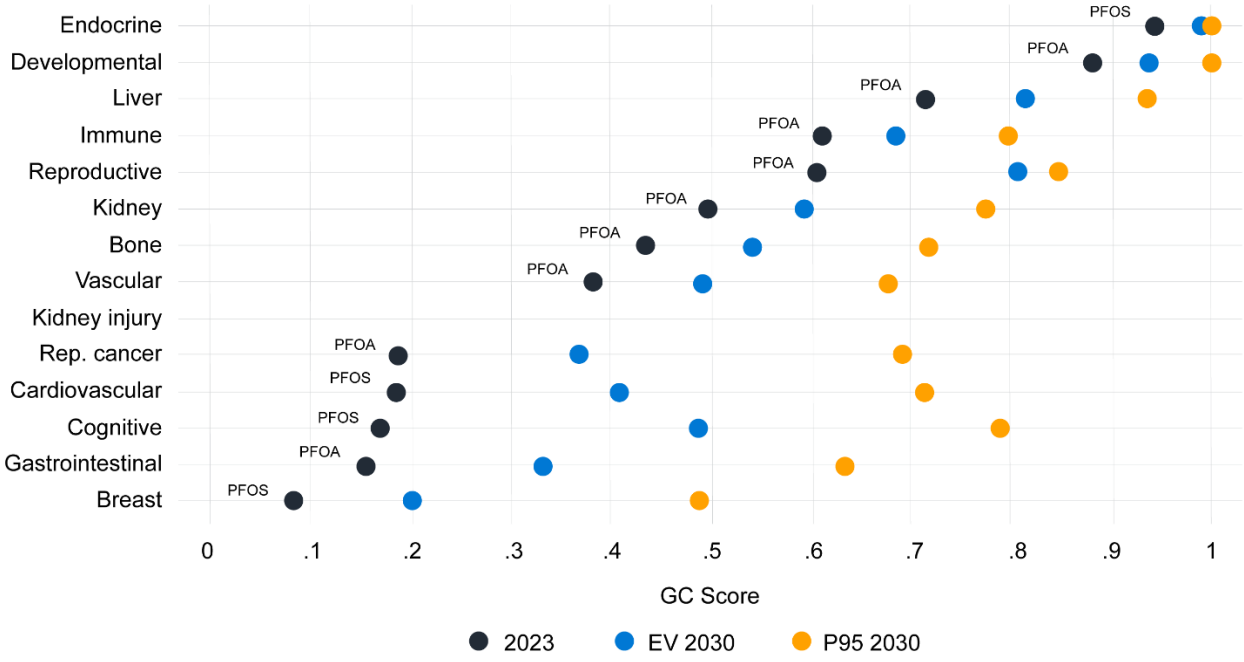
8 Shih, Y., Blomberg, A., Bind, M., Holm, D., Nielsen, F., Heilmann, C., Weihe, P., & Grandjean, P. (2021). Serum vaccine antibody concentrations in adults exposed to per- and polyfluoroalkyl substances: A birth cohort in the Faroe Islands. J Immunotoxicol 18.

9 Dalsanger, L., Christensen, N., Halekoh, U., Timmerman, C., Nielsen, F., Kyhl, H., Husby, S., Grandjean, P., Jensen, T., & Andersen, H. (2021). Exposure to perfluoroalkyl substances during fetal life and hospitalization for infectious disease in childhood: A study among 1,503 children from the Odense Child Cohort. Environ Int 149.

10 Grandjean, P., Timmerman, C., Kruse, M., Nielsen, F., Vinholt, P., Boding, L., Hellmann, C., & Molbak, K. (2020). Severity of COVID-19 at elevated exposureto perfluorinated alkylates. PLoS ONE 15.

Today, the scientific evidence in support of many of the C-8 hypotheses is far from conclusive, according to Praedicat's GC risk score metrics. Figure 2 shows current GC risk scores for 14 PFOA/PFOS hypotheses. GC risk scores for kidney and testicular cancer (reproductive cancer) are 0.50 and 0.19, respectively. GC risk scores for ulcerative colitis (gastrointestinal injury), pregnancy-induced hypertension (reproductive injury), and high cholesterol (cardiovascular injury) are 0.16, 0.61, and 0.18, respectively. Thyroid injury, which is included among the endocrine system and developmental injury hypotheses, is the most well supported according to these analytics. And liver injury, which the C-8 Science Panel considered but concluded had insufficient evidence to establish a "probable link," is now among the most well-supported bodily injury hypotheses in the peer-reviewed literature.[11]

FIGURE 2: GENERAL CAUSATION RISK SCORE IN 2023 AND AS PROJECTED IN 2030, BY BODILY INJURY TYPE: PFOA AND PFOS

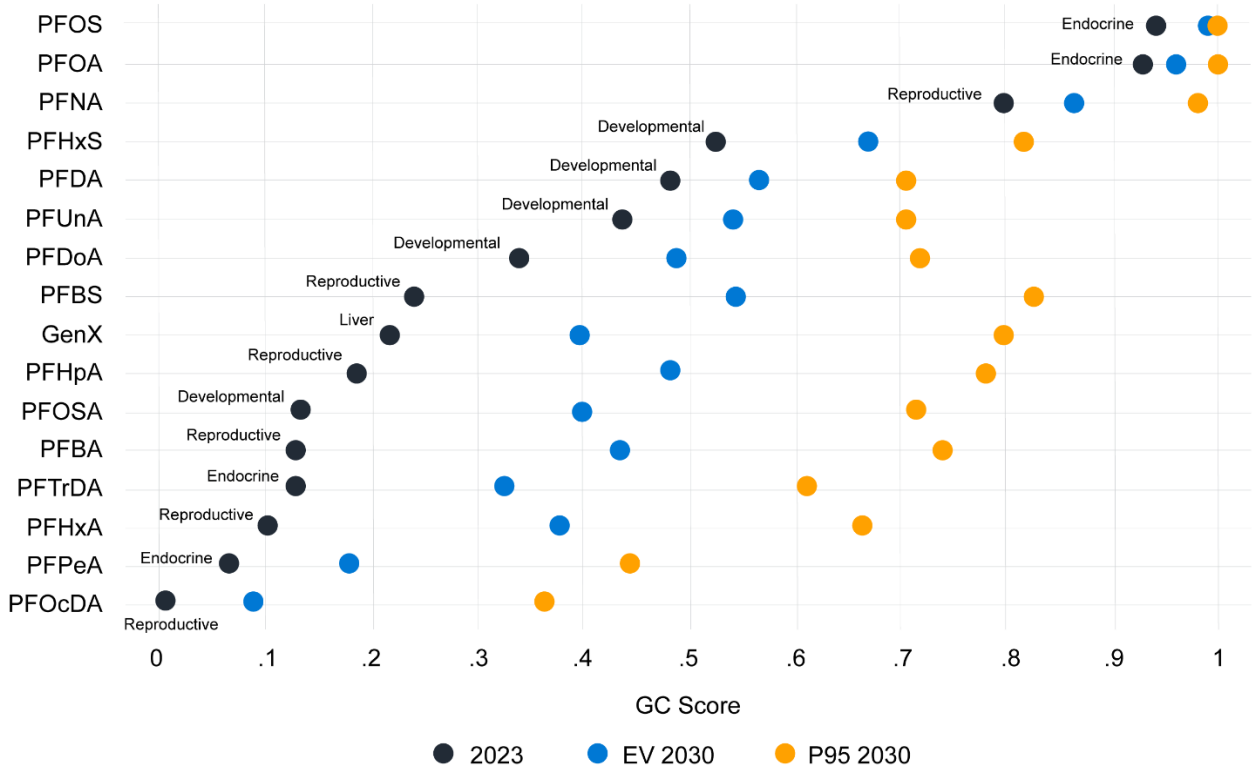


Source: Praedicat general causation risk model

One of the difficulties inherent in studying the human health effects of PFAS is the sheer number of individual PFAS found in the environment today. PFOA and PFOS are far and away the most heavily studied PFAS. Praedicat's database includes more than 950 studies on PFOA and PFOS, whereas studies across 14 other individual PFAS tracked by Praedicat number about 450 in total. As a result, GC risk scores for PFAS other than PFOA and PFOS are generally lower by comparison (see Figure 3). The ongoing commercial use of these individual PFAS, however, continues to attract the attention of the scientific community, suggesting a strong likelihood that scientific support will continue its upward trend (see GC risk score projections in Figure 3).

11 Projected GC risk scores shown in Figure 2 are derived from a statistical model of the likelihood new studies will appear in a literature that support a given hypothesis. EV 2030 is the expected value of the GC risk score for a given hypothesis in 2030 and P5 2030 is the GC risk score at the 5th percentile of projected scores in that year.

FIGURE 3: GENERAL CAUSATION RISK SCORE IN 2023 AND AS PROJECTED IN 2030, BY INDIVIDUAL PFAS



Source: Praedicat general causation risk model

Federal and state governments take action

While scientific evidence supporting claims of specific injury following exposure to specific PFAS is thin in many cases, there is overwhelming consensus among scientists and regulators throughout the world that PFAS as a class poses a significant public health threat. Concern is so great that this past February the European Chemicals Agency announced it is considering a near total ban on the production and use of PFAS to be phased in beginning as early as 2027.[12] In the United States, state legislatures and regulators are increasingly taking action to ban specific applications of PFAS, but perhaps the most significant regulatory development thus far is the proposed establishment of an enforceable nationwide drinking water standard by the EPA.

In March 2023, the EPA announced the proposed National Primary Drinking Water Regulation for six PFAS. When finalized, the regulation will establish a legally enforceable maximum contaminant level (MCL) of 4 parts per trillion (ppt) for PFOA and PFOS. This standard is well below the non-enforceable 70 ppt health advisory standard the EPA established for PFOA and PFOS in 2016. The EPA also proposed a novel approach to regulating four individual PFAS as a group: perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), perfluorobutane sulfonic acid (PFBS), and hexafluoropropylene oxide dimer acid (GenX). For these four PFAS, water utilities must measure levels relative to standards of 10 ppt for PFNA, 9 ppt for PFHxS, 2,000 ppt for PFBS, and 10 ppt for GenX. The sum of these hazard quotients must not exceed 1.0.[13] Public water systems that test above these MCLs must take actions to come into compliance, including installing costly water treatment technologies.

12 See https://echa.europa.eu/-/echa-publishes-pfas-restriction-proposal.

13 See https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas.

While final implementation of the EPA's PFAS drinking water standards are likely to be delayed by legal challenges, many states have already adopted enforceable standards or are close to doing so. A standard of 14 ppt for PFOA and 18 ppt for PFOS, for example, is now in effect in Pennsylvania, and Rhode Island has capped total PFAS in drinking water at 20 ppt. Other states with enforceable drinking water standards include Maine, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, and Vermont. Thirteen other states have adopted non-enforceable health advisories for PFAS in drinking water.[14]

PFAS labeling requirements and bans prohibiting the intentional addition of PFAS in products are also coming into effect in many states. Legislatures in Maine, Minnesota, and Washington, for example, have directed state agencies to implement regulations banning all but essential uses of PFAS over the next five to 10 years. These and other states have also adopted regulations requiring companies to disclose intentionally added PFAS in products. Specific PFAS product bans now or soon to be in effect include paper plates, cups, bowls, and other food packaging in New York; children's products in California; cookware, dental floss, and menstrual products in Minnesota; and textiles such as apparel, rugs, and upholstery in California, Colorado, Maryland, New York, Vermont, and Washington. Twelve states ban PFAS in food packaging, four states ban PFAS in personal care products, and 11 states restrict the use of PFAS in firefighting foam.

PFAS litigation: A history spanning decades

PFAS litigation began in West Virginia in 1999 when Wilbur Tennant filed a complaint in the Southern District of West Virginia against DuPont, alleging the company was dumping hazardous waste adjacent to his property and that the waste was contaminating surface and groundwater on his property, sickening and killing his cattle, and making him and his family "physically ill." According to Tennant's lawyer, Robert Bilott, Tennant was furious that DuPont was polluting his land with impunity.[15] Appeals to state environmental regulators went nowhere and he felt legal action was his only recourse. Little did Tennant know that his would be the first of more than 9,800 complaints filed against DuPont and other manufacturers and users of PFAS chemicals in a mass litigation event that is still going strong 24 years later.

Through painstaking discovery, Bilott eventually determined that it was PFOA that was responsible for turning the stream that ran through Tennant's property into a sudsy mess and, he suspected, sickening Tennant's cattle. PFOA was used to manufacture DuPont's miraculous Teflon coating at its Washington Works facility in Parkersburg, West Virginia. Tennant settled his lawsuit with DuPont in 2001 for an undisclosed amount, but Bilott, who now knew a lot about DuPont and PFOA and the health of the community surrounding Washington Works, was just getting started. In that same year, Bilott filed a class-action lawsuit (*Leach v. DuPont*) on behalf of all individuals exposed to PFOA in drinking water in the vicinity of Washington Works. The suit alleged that PFOA exposure elevated the risk of latent disease in the class (including cancer) and demanded DuPont and the local water utility pay for ongoing medical monitoring and damages for bodily injury should they emerge.

The *Leach* settlement in 2004 resulted in the establishment of the independent C-8 Science Panel described earlier. The panel's affirmation of a probable link between PFOA exposure in the Mid-Ohio Valley and six disease conditions, including kidney and testicular cancer, resulted in the formation of multidistrict litigation (MDL) in the Southern District of Ohio in 2013 (IN RE: E.I. du Pont de Nemours and Company C-8 Personal Injury Litigation). The MDL would grow to more than 3,700 cases by the time DuPont settled most of them in 2017 for $671 million in the wake of plaintiff verdicts in three bellwether trials. Another 95 complaints settled in January 2021 for $83 million; a few dozen cases in the MDL remain unsettled.

14 See https://www.saferstates.com/toxic-chemicals/pfas/.

15 Billot, R. (2019). Exposure: Poisoned Water, Corporate Greed, and One Lawyer's Twenty-Year Battle Against DuPont. Atria Books.

According to Praedicat's PFAS litigation tracker, only 25 PFAS complaints were filed prior to the formation of the C-8 MDL in 2013, and most of those were centered on Washington Works and a set of ultimately unsuccessful consumer class actions alleging Teflon-coated pans emitted dangerous fumes when heated to high temperatures.[16] Among those 25 complaints, though, were two filed in 2009 by water utilities in Florida and Ohio and another by the state of Minnesota in 2010 seeking compensation for the contamination of drinking water supplies with PFAS. Initially, drinking water lawsuits focused on PFAS discharges from chemical plants. By 2016, though, plaintiffs were homing in on another source of contamination: aqueous film-forming foams (AFFF) used to fight fires, especially at military airfields and commercial airports. For the first time since the unsuccessful Teflon cookware class action, PFAS litigation was now focused not only on improper disposal of the chemicals, but on the defective products that contain them as well. Individuals, drinking water utilities, and local governments in Colorado, Delaware, Florida, Massachusetts, New York, Pennsylvania, and Washington alleged that AFFF had contaminated drinking water with PFAS; not only were manufacturers of PFAS to blame, but so were the companies that made AFFF, the equipment to disperse it, and the airports that used it.

Seventy-five AFFF lawsuits were consolidated in multidistrict litigation in South Carolina in December 2017, naming 3M and DuPont along with dozens of other companies (IN RE: Aqueous Film-Forming Foams Products Liability Litigation). The AFFF MDL has now ballooned to more than 5,600 cases and includes claims of property damage by water districts, municipalities, commercial water companies, and individual property owners. In addition, individual consumers of PFAS-contaminated drinking water have alleged bodily injury (typically, one of the six "probable link" health conditions established by the C-8 Science Panel) and fear of developing bodily injury. There are also bodily-injury claims of former firefighters, airport workers, and military personnel that work with AFFF. Some firefighter cases allege exposure to PFAS exposure in turn-out gear. Additionally various state's attorneys general have sued seeking monies to remedy damage to the natural resources of their states.

PFAS complaints are proliferating outside the AFFF MDL as well—more than 300 since 2018. Complaints alleging improper disposal from chemical plants (e.g., cases centered around plants operated by 3M, Saint-Gobain, Solvay, and Chemours) are common, but complaints have also emerged focused on other products and industries like carpet mills, shoe manufacturing, firefighting apparel, paper mills, biosolids, compostable plates, and even underwear. DuPont and 3M have also been sued by investors claiming they failed to disclose the extent of their PFAS liabilities in a timely fashion. Numerous lawsuits have been filed against various companies alleging deceptive marketing or misrepresentations of advertising materials of products containing PFAS. Litigation has been filed against manufacturers of PFAS-containing products, including fast food packaging, rain jackets, feminine hygiene products, cosmetic products, and dental floss. In most of these cases, the products are alleged to be advertised as "safe" or "sustainable." While currently these cases focus on the alleged deceptions in marketing, it is not hard to imagine a wave of bodily injury suits wherein the plaintiffs allege injuries as a result of exposure to PFAS containing products.

16 See https://www.law360.com/articles/101164/teflon-mdl-shuts-down-after-class-cert-appeal-fails.

Estimating future damages

What began in 1999 as a single complaint by a West Virginia farmer against a single company is now a multi-decade mass litigation event that has spread far beyond the pioneers of PFAS chemistry. As of September 2023, Praedicat's litigation tracker records more than 9,800 PFAS complaints, filed in 123 courts, naming 357 companies operating in 140 industries.

A relatively small number of companies have settled PFAS lawsuits to date (see the table in Figure 4). In June 2023, with the bellwether trial in the AFFF MDL underway, 3M announced that it had agreed to pay as much as $12.5 billion over 13 years to resolve current and future property damage claims filed by water districts. Also in June, DuPont, Chemours, and Corteva announced they had reached a settlement of $1.185 billion to resolve similar claims. Importantly, these settlements do not resolve the thousands of property damage or bodily injury claims made by individuals in the AFFF MDL and it remains to be seen whether a sufficient number of water districts will sign on to these settlements to make them viable. Attorneys general for 19 states, the District of Columbia, and two U.S. territories, for example, recently argued in court that the proposed 3M settlement may be a bad deal for many water districts.[17]

DuPont, Honeywell, Johnson Controls, Saint Gobain, Solvay, 3M, and Wolverine have settled a small number of additional property and natural resource damage cases over the past 19 years, totaling approximately $1.8 billion, including 3M's $850 million settlement with the state of Minnesota in 2018. DuPont and Johnson Controls are the only two companies to date to have settled bodily injury claims. As previously noted, DuPont settled 3,550 bodily injury cases in the C-8 MDL for $671 million in 2017 and another 95 complaints in 2021 for $83 million. Prior to the C-8 MDL settlement, juries in three bellwether trials held DuPont liable for cancer claims, awarding plaintiffs a total of $19.7 million. More recently, in 2020, a jury awarded $40 million to a man who alleged PFOA-contaminated drinking water caused his testicular cancer. And, in 2022, Johnson Controls agreed to pay $17.5 million to settle about 300 cases in Peshtigo, Wisconsin, to resolve both property damage and bodily injury claims.

FIGURE 4: NOTABLE PFAS JURY AWARDS AND SETTLEMENTS: 2004-2023

DATE	CASE	DEFENDANT(S)	SETTLEMENT AMOUNT	DESCRIPTION
June 2023	IN RE: Aqueous Film-Forming Foams Products Liability Litigation	3M	$10.1-12.5 billion	Resolves property damage claims related to AFFF contamination of public drinking water supplies.
June 2023	IN RE: Aqueous Film-Forming Foams Products Liability Litigation	DuPont, Chemours, Corteva	$1.2 billion	Resolves property damage claims related to AFFF contamination of public drinking water supplies.
June 2023	New Jersey Department of Environmental Protection et al. v. Solvay Specialty Polymers USA LLC	Solvay	$393 million	Resolves state claims regarding PFAS pollution in the vicinity of Solvay's West Deptford, New Jersey, facility.
March 2023	Zimmerman et al. v. 3M Co. et al	3M, Wolverine	$54 million	Resolves property damage claims by private property owners in the vicinity of Wolverine's Kent County, Michigan, facility.
February 2022	Baker et al. v. Saint-Gobain Performance Plastics, et al.	Saint-Gobain Performance Plastics, 3M, Honeywell	$65 million	Resolves property damage and medical monitoring claims in the vicinity of Saint-Gobain's Hoosick Falls facility.
October 2021	Burdick v. Tonoga Inc.	Tonoga	$23.5 million	Resolves property damage and medical monitoring claims by property owners in the vicinity of Tonoga's Petersburgh, New York, facility.
July 2021	Delaware v. DuPont et al.	DuPont, Chemours, Corteva	$50 million	Resolves environmental resource damage claims in the state of Delaware.

17 See https://oag.ca.gov/system/files/attachments/press-docs/Amicus%20Letter%20-%20Filed.pdf.

DATE	CASE	DEFENDANT(S)	SETTLEMENT AMOUNT	DESCRIPTION
April 2021	Dykehouse v. 3M et al.	3M, Geogia-Pacific	$11.9 million	Resolves property damage claims in the vicinity of Georgia-Pacific's Michigan paper mill.
March 2021	Bemidji v. 3M	3M	$12.5 million	Resolves property damage claims related to AFFF contamination of private wells in the vicinity of a regional airport in Bemidji, Michigan.
January 2021	Campbell et al. v. Tyco Fire Products L.P.	Johnson Controls	$17.5 million	Resolves bodily injury and property damage claims in the vicinity of Tyco's Peshtigo, Wisconsin, fire training center.
November 2021	Sullivan et al. v. Saint-Gobain Performance Plastics	Saint-Gobain Performance Plastics	$34 million	Resolves property damage and medical monitoring claims in the vicinity of Saint-Gobain's Bennington, Vermont, facility.
October 2021	West Morgan-East Lawrence Water and Sewer Authority v. 3M et al.	3M, Daikin America	$98.4 million	Resolves drinking water utility's claims stemming from PFAS contamination of the Tennessee River.
October 2021	Tennessee Riverkeeper v. 3M Company; Lindsey et al. v. 3M Company; City of Decatur v. 3M Company	3M	$99 million	Resolves environmental resource and property damage claims stemming from PFAS contamination of the Tennessee River.
January 2021	Swartz v. DuPont	DuPont, Chemours, Corteva	$50 million	Plaintiff verdict holding DuPont liable for plaintiff's kidney cancer.
January 2021	IN RE: E.I. du Pont de Nemours and Company C-8 Personal Injury Litigation	DuPont	$83 million	Settles 95 bodily injury cases pending in the C-8 MDL.
February 2020	Johns v. Wolverine World Wide et al.	3M, Wolverine World Wide	$69.5 million	Resolves property damage claims in the vicinity of Wolverine's Plainfield, Michigan, facility.
May 2020	Abbott v. E.I. DuPont de Nemours & Co.	DuPont	$40 million	Plaintiff verdict holding DuPont liable for man's testicular cancer caused by PFOA exposure in vicinity of DuPont's Parkersburg, West Virginia, facility.
May 2020	Lake Elmo v. 3M	3M	$2.7 million	Resolves property damage claims related to PFAS contamination from landfills in the vicinity of Minneapolis, Minnesota.
February 2018	State of Minnesota v. 3M	3M	$850 million	Resolves drinking water and natural resource damage claims in the vicinity of Minneapolis, Minnesota.
February 2017	IN RE: E.I. du Pont de Nemours and Company C-8 Personal Injury Litigation	DuPont, Chemours	$671 million	Settles 3,550 bodily injury claims stemming from PFOA exposure in the vicinity of DuPont's Parkersburg, West Virginia, facility.
December 2016	Vigneron v. DuPont	DuPont	$12.5 million	Plaintiff verdict holding DuPont liable for plaintiff's testicular cancer caused by PFOA exposure in vicinity of DuPont's Parkersburg, West Virginia, facility.
July 2016	Freeman v. DuPont	DuPont	$5.6 million	Plaintiff verdict holding DuPont liable for plaintiff's testicular cancer caused by PFOA exposure in vicinity of DuPont's Parkersburg, West Virginia, facility.
October 2015	Bartlett v. DuPont	DuPont	$1.6 million	Plaintiff verdict holding DuPont liable for plaintiff's kidney cancer caused by PFOA exposure in vicinity of DuPont's Parkersburg, West Virginia, facility.
November 2004	Leach et al. v. DuPont	DuPont	$405 million	Settles class action claims related to PFOA exposure in the vicinity of DuPont's Parkersburg, West Virginia, facility. Settlement funds C-8 Science Panel and installation of water filtration systems.

Ultimate losses to PFAS defendants could greatly exceed the roughly $16.7 billion in finalized and proposed judgments levied on and settlements agreed to by PFAS defendants to date. With current water remediation technology, Praedicat estimates that the nationwide cost of remediating drinking water contaminated with PFAS to a standard of 7 ppt over a 20-year time horizon could be as high as $370 billion.[18] And bodily injury claims could increase the ultimate cost of PFAS litigation to corporate defendants further. Praedicat's probabilistic liability catastrophe model generates estimates of the ultimate cost to companies that have already or could in the future be named in PFAS-related bodily injury lawsuits. The model accounts for the strength of scientific evidence that plaintiffs can rely on today and how that science could evolve in the future, in addition to the number of workers and consumers who can both demonstrate exposure to PFAS and that they suffer a bodily injury conceivably caused by PFAS. Over thousands of simulations, the model generates an expected cost of $16 billion across all PFAS defendants. And there are simulations in which the ultimate costs could be much higher. The model indicates a 5% probability that total settlements and defense costs incurred in bodily injury lawsuits could exceed $70 billion.

A multifaceted approach to setting PFAS reserves

Estimating PFAS reserves is complicated by limited experience. Historical claims experience associated with PFAS liabilities is thin and volatile. As displayed in the table in Figure 4, a small number of companies have announced settlements to date and many of those settlements have yet to be finalized. Standard reserving methods that rely upon historical claims patterns are unlikely to produce useful estimates of future liabilities for an event as complicated as PFAS, in which there are thousands of unresolved complaints pending in U.S. courts and potentially many thousands if not tens of thousands of additional complaints that could be filed in the future, should science lend further support to the possibility that exposure to PFAS in myriad industrial and consumer products elevates the risk of serious bodily injury. But while the future development of known PFAS claims, incurred but not enough reported (IBNER), and unknown PFAS claims, incurred but not reported—"pure" IBNR—is highly uncertain, this uncertainty is not reason alone to delay estimating PFAS reserves today.

PFAS are hardly the first difficult reserving problem faced by casualty actuaries. Many of the reserving techniques developed to address complex emerging risks like asbestos are relevant to the problem of reserving for PFAS today. In this section, therefore, we begin by highlighting the shortcomings of traditional actuarial methods for a problem like PFAS and discuss the applicability of methods that have been employed for establishing reserves in the case of asbestos, pollution, and health hazard (APH) as well as other historical emerging risks. We then describe ongoing coverage disputes and the uncertainty introduced by PFAS reserving. We conclude with the observation that the increased availability of data linking companies to specific business activities that expose workers and consumers to PFAS—coupled with the ability to simulate the development of scientific evidence, emergence of specific litigation events, and eventual settlements—opens up new avenues for estimating PFAS reserves dominated by IBNER and IBNR claims.

WHY TRADITIONAL ACTUARIAL METHODS ARE INAPPLICABLE

Actuaries have difficulty estimating liabilities for PFAS using traditional actuarial reserving approaches, such as chain ladder and Bornhuetter-Ferguson, due to various complicating factors.

For starters, many traditional actuarial methods require historical claims experience to be representative of future expected claims. This requirement poses a challenge given that there are only a handful of PFAS insurance losses reported to date. The scarcity of relevant historical data makes it difficult to derive essential method assumptions (e.g., development factors, a priori ultimates, loss ratios).

18 Praedicat's estimates are based on cost figures that informed Minnesota's 2018 settlement with 3M. Advances in water remediation technology could lower ultimate costs, perhaps substantially.

Traditional actuarial methodologies generally aggregate claims into time periods (e.g., accident year, policy year) to group claims that are likely to experience similar future development. It is difficult to cleanly aggregate PFAS and other APH losses by accident year, because the damages often accumulate over a broad window of time instead of a particular date. For example, a claimant may be exposed to asbestos over the course of a decade and eventually leading to mesothelioma, whereas a car accident could cause immediate bodily injury. Assignment to policy year is also difficult because PFAS and other APH losses are often allocated to multiple policies based on the known coverage language and the legal interpretation of the coverage. Report year can be used instead of accident year or policy year to avoid ambiguity, as is often done when analyzing asbestos liabilities. However, this still requires credible historical claims data, which is currently lacking for PFAS.

Alleged injuries and damages culminating from exposure to PFAS and other APH take a long time to manifest, meaning that there are significant time lags between the date of injury or damage and the date of report. Long periods of litigation could also extend the time lag between the date of report and date of closure. To illustrate, a company is dumping hazardous material into a river for decades, but the material is not discovered in drinking water until years later. Additionally, it could be decades until claimants allegedly develop a disease from ingesting that material in drinking water, followed by years of litigation to resolve the claim. Some traditional actuarial methodologies can handle long-tailed liabilities with significant report lag to the extent that the data is mature enough to assess development patterns or credible enough to derive assumptions for exposure-based methods. Data for PFAS and many other APH exposures do not meet either of these thresholds.

APH RESERVING METHODOLOGY

While traditional actuarial methods do not provide an effective framework for estimating PFAS liabilities, other accepted methodologies could be applied. APH reserving methodologies may be unfamiliar to many actuaries, yet most of the potential approaches have been well documented and discussed dating back decades to coincide with the first significant wave of asbestos liabilities. The methods have evolved incrementally throughout this time span to consider access to additional data sources and respond to the evolving nature of the underlying exposures. Commonly used APH methods can be segmented into industry benchmark or company-specific approaches. The company-specific approaches can be further divided into aggregated or insured account-level methods. The approach taken for each reserving assignment is highly dependent on the granularity of the information available and the reliability of historical data.

INDUSTRY BENCHMARK METHODS

Common industry benchmark methods include Survival Ratio (paid and incurred), Market Share, IBNR to Case, and Percentage of Paid methods. While these are industry methods, they still require data from the specific company, summarized by exposure type (i.e., asbestos, pollution, or other health hazard). The Survival Ratio and Market Share methods require recent company calendar year activity, the IBNR to Case method requires established case reserves, and the Percentage of Paid method requires the total historical payments. In some instances, this information may be difficult to obtain, so only a subset of industry benchmark methods can be relied upon.

Beyond company-specific data, these methods also require credible sources of industry data to develop the ratios applied in each method. High-level aggregated data for the total APH industry can be found in various reports, often segmented by asbestos and environmental. While this data can be useful, it is comprised of a wide variety of companies, which is often not the best fit for the reserving task at hand. Company-level industry data can also be obtained by reviewing each company's Note 33 in the National Association of Insurance Commissioners (NAIC) Property/Casualty Annual Statements or a subscription with a data vendor. The company-specific information provides the actuary with much more control to aggregate the data into companies with similar risks. It also affords the opportunity to adjust for large transactions and remove outliers.

If industry and company data are readily available, the industry benchmark methods can be useful to derive reasonable estimates quickly for asbestos and environmental exposures. However, the resulting estimates typically should not be relied upon as the sole methodologies if the goal is to derive accurate company-specific liability estimates. The high-level nature of the indications will produce estimates that are in line with industry reserving practices, but do not fully consider underlying predictive attributes, such as the accounts a company insured, the types of policies a company wrote, and the details of the hazardous exposures, including but not limited to the insured's industry, product liability versus premises, resulting disease, firsthand versus secondhand exposure, venue of litigation, claimant demographic information, type of pollutant, and description of the cleanup site.

Industry benchmark methods are likely even less accurate for PFAS exposures for a few reasons. First, reputable industry sources do not separate PFAS settlements from other APH, and many PFAS settlements to date are likely classified as environmental liabilities. While PFAS settlements may be represented in the industry data, they are not yet pervasive, meaning that the industry metrics utilized are not directly representative of PFAS liabilities. When looking at company-specific industry data, it may be difficult to parse out which insurance carriers underwrote accounts with PFAS exposures. Additionally, exposure to PFAS can take different forms, leading to different types of liabilities. For instance, dumping of PFAS-containing waste could lead to environmental cleanup costs, whereas a PFAS-containing product could cause bodily injury. As such, it may not be appropriate to simply apply environmental industry metrics to handle cleanup liabilities or to use asbestos metrics as a proxy for PFAS bodily injury.

Beyond the lack of pervasive PFAS industry data, the company-specific data is also lacking. Historical activity is limited to a handful of claims and case reserves are difficult to set given emerging litigation. If the rate of PFAS litigation continues to increase, a company may soon be able to obtain partially credible data on related insurance losses. Given the right data and ability to segment losses to more granular exposure types, it would be possible to apply well-tailored versions of the Survival Ratio or Market Share methods. It is too early to assess whether these estimates will prove to be reasonably accurate, but they may provide a starting point to quantify PFAS liabilities.

AGGREGATED COMPANY-SPECIFIC APPROACHES

Industry benchmark methods can produce reasonable estimates, especially in instances where more granular company data is not readily available. However, when more granular data is available, company-specific approaches should be considered for a more tailored reserve estimate.

Most company-specific APH methods are derived from traditional frequency times severity methodologies, where future counts are estimated and multiplied by a selected future severity. Usually, the traditional frequency times severity methods define frequency as a rate of claims counts over an exposure base (e.g., premium, payroll, sales). That rate is then multiplied by an actual or estimated exposure base to produce an estimated count. This traditional approach is less intuitive for APH liabilities, because the insured occurrence and relevant exposure base may be decades old. Instead, APH frequency times severity methodology relies on the direct projection of future claims count emergence, without utilizing an exposure base.

Future claims count emergence can be calibrated using a variety of predictive attributes, and the methods can be structured using filed/reported claims or settled/closed claims. The method can be run using "claimant counts," representing the underlying plaintiffs filing claims against an insured, or "claims counts," representing the insureds filing claims against the insurance carrier (for the sake of simplicity, the term "claims counts" will be used throughout). The core process involves evaluating historical claims decay rates (i.e., the relative decrease or increase in claims counts over time) and fitting a curve to project future counts. This is why these methods are sometimes referred to as "decay methods," in addition to frequency times severity methods.

When estimating asbestos claims, actuaries have historically relied upon epidemiological studies tied to the emergence of marquee diseases, such as the Nicholson curve for mesothelioma. There are concerns with relying heavily on these epidemiological curves, as they often suggest that the peak of disease incidence occurred over a decade ago, when there is plenty of more recent data to suggest otherwise. The serial underprediction of APH claims is a topic best explored in its own paper. However, it is important to note, as it creates additional importance for using company-specific historical data along with other predictive attributes, including insured account industry and litigation venue.

Unlike asbestos, PFAS have been linked to many diseases and medical conditions in certain studies, as discussed above. Additionally, many epidemiological studies focused on PFAS exposure are ongoing and the science is not settled on the impacts of PFAS on human health. The results of these studies should continue to be monitored along with the alleged diseases brought forth in litigation. It is possible that strong links will be found between PFAS and a certain disease, allowing for a similar handling to asbestos and mesothelioma. It is also possible that the links to health hazards may remain broad, requiring additional segmentation of the claims data to produce homogeneous estimates. If this is the case, it will be important to segment alleged disease by the seriousness of the outcome and manifestation lag.

In considering how to best aggregate data for an APH portfolio, the actuary should follow the same principles of actuarial risk classification used for any property and casualty reserves, as outlined in Actuarial Standard of Practice No. 12 (ASOP 12). It states that the actuary needs to consider homogeneity, credibility, and practicality to determine the most appropriate aggregation level for an analysis. The actuary often needs to weigh trade-offs in determining the right level of aggregation. For example, a high level of credibility is often achieved by creating a less homogeneous group. Another trade-off is that creating very homogeneous groups may not be practical when considering the cost and time needed to compile the data and analyze a greater amount of segmented reserve estimates.

Keeping this in mind, company-specific approaches should at least be aggregated separately by exposure type (e.g., asbestos, pollution, other health hazard) but more granular aggregation is often beneficial to produce more refined estimates. Segmenting the analysis by insured industry and disease type can be especially useful to gain homogeneity, but this can often create practical difficulties. The former can be quite time-consuming because account industry is not typically contained in insurer databases, and the latter requires claimant-level data to separate individuals afflicted by different diseases.

When analyzing PFAS, the actuary should consider whether company-specific PFAS claims have enough credibility to be aggregated separately or, on the other hand, whether PFAS claims are homogeneous enough with other historical exposure types (primarily environmental and other health hazards) to be included there. Most PFAS claims to date are likely being classified as environmental claims in insurers' data, so it would be beneficial to identify these claims now to allow separate aggregation when appropriate. The distinction between property damage and bodily injury is also essential, as these PFAS exposures have distinct differences. The challenges of where to best include PFAS claims in data aggregation underscores why it may be best to consider insured account level approaches to estimate PFAS reserves.

INSURED LEVEL COMPANY-SPECIFIC APPROACHES

When an actuary has access to information about the insureds (or "accounts"), it may allow for a more granular insured-specific estimate. Preliminary data by insured account, including company name, policy years, paid losses by calendar year, and case reserves provide information to segment insureds into homogeneous groups for an aggregate analysis as described above. Additional information, such as the date of last case reserve assessment, details about ongoing litigation, discussions with plaintiff lawyers, claimant demographics, cleanup site attributes, and venue of litigation, allow for a more detailed insured account-level approach.

As already established, traditional actuarial methods use historical claims data from the analyzed risk segment to project future liabilities. When analyzing unique or emerging risks, such as PFAS, there is rarely useful historical claims data to use in these projections. As such, other sources of historical information need to be utilized when calibrating the reserve model assumptions. This historical information could include total settlement amounts from similar litigation, legal precedent in the applicable venue, claimant-level severities, and cleanup costs, among other data points. This historical information needs to be supplemented with current facts from the ongoing litigation involving the insured account.

Synthesizing the various sources of information, both historical and current, requires expertise beyond a typical actuary's tool kit. Knowledgeable claims-handling staff is needed to collect the details that are relevant in estimating case reserves and developing settlement strategies. Well-versed legal experts are needed to point to established precedent and probable litigation outcomes given the current facts of the case. The reserving actuary's role is to understand the implications of the information provided by these external experts to translate it into insurance costs. This is often a collaborative process to confirm that details are well understood by all involved parties.

Perhaps the trickiest piece to the insured account-based methodology is that there is not a strict blueprint to follow. The approach is largely dictated by the information available, and confidence in the final estimate can vary widely. An actuary needs to be well-versed in the principles of traditional actuarial methodology to apply them inside a novel framework. With limited historical claims data to analyze, an actuary is best suited following the key tenets of the frequency times severity framework or an exposure-based methodology. The basis of those methods is dependent on the underlying risk. For example, environmental liabilities may assess severity at the site level, while sexual misconduct liabilities are best calibrated as claimant-level severities. For emerging risks, there is often not significant precedent to dictate the proper way to handle this methodology, so it is important to learn from similar risks while following established best practices.

Calibrating model assumptions, such as severities, for an emerging risk like PFAS is not an easy task, but options exist to produce reasonable estimates. For example, a PFAS drinking water claim could be approached in a "ground-up" manner, such as estimating the cost of water filtration systems by the number of affected properties or individual wells, or it could be calibrated at a higher level, such as prior settlement amounts per municipality. Utilizing multiple approaches could also be useful to produce a range of potential liabilities. Taking it a step further, the uncertainty surrounding each of the underlying assumptions lends itself well to a stochastic approach, which allows for the projection of outcomes under various scenarios.

Despite its difficulties, the insured account-based approach is a better fit for PFAS liabilities compared to aggregate methodology, to the extent that account-level information is available. Through the process, actuaries should be collaborative with external experts in developing these approaches, while being mindful of the best practices governing the use of third-party models and expertise. Most notably, the actuary should gain enough understanding of any external methodology used to derive assumptions to assess its reasonability. The actuary should also be cautious to produce an independent estimate that is not unduly influenced by external experts, and to clearly state when assumptions and estimates are directly derived from these outside sources.

COVERAGE DISPUTES AND NET LIABILITIES

The discussion of methodology to this point has not drawn a distinction between whether the approach is directly estimating gross or net liabilities. The approach to determine net liabilities is dictated by available data, the insurer's position in the coverage chart, known details of the underlying policies, and resulting coverage litigation. In some instances, the actuary has access to "ground-up" claims data, allowing for the projections of gross liabilities that can then be reduced to represent a carrier's share of the liabilities. In other situations, the provided data may only represent the payments made by the individual carrier, allowing for a direct projection of net liabilities.

Many situations are not straightforward, given that policy structure varies by insured account, and the responding policies can be over 50 years old. Lost policies and changed policy language through the years leave much of the interpretation up to court systems, which are also not consistent in how certain coverage situations are handled. For these reasons, it is often imperative to analyze the exposed policy limits and potential coverage scenarios directly at the insured account level. This process can be somewhat arduous, but it is important to at least consider for the largest accounts with significant liabilities.

Even at the account level there is often still uncertainty surrounding how potential insurance will respond to PFAS liabilities given ongoing coverage disputes. A few key policy considerations and their potential application to PFAS are discussed below.

PFAS COVERAGE DISPUTES

With all PFAS insurance claims, there are several questions that may need to be addressed in a fulsome coverage analysis. As a threshold matter, PFAS claims can potentially implicate several policies, including those that provide coverage for general liability and commercial general liability, pollution legal liability, first-party property, and even directors and officers (D&O) coverage. While most contemporary policies are likely to contain a total PFAS exclusion, such exclusions are likely not going to be present in earlier policy periods. However, depending on the policy wording and PFAS exposure involved, there are still several coverage questions that a policyholder will need to answer before assessing coverage for its claims.

Application of the pollution exclusion

Most insurance policies that were written after 1970 will likely have some form of a pollution exclusion. While the wording of pollution exclusions differs, they generally exclude coverage for claims that arise from the discharge, dispersal, release, or escape of pollutants or contamination under varying circumstances. PFAS claims may very well fall under this type of coverage exclusion. Indeed, there is currently a slowly developing body of case law related to the coverage issues involving PFAS. Given this dynamic and perhaps not surprisingly, many of the first PFAS litigation coverage cases have addressed the application of these pollution exclusions. As one would expect, the outcome of the cases is highly dependent on the specific pollution exclusion language at issue and which state's law is being applied.

Take, for example, *Tonoga Inc. v. New Hampshire Ins. Co*., 201 A.D.3d 1091 (N.Y. App. Div. 2022), in which a manufacturer of water-resistant clothing that used PFOA and PFOS in its decades-long manufacturing process (Tonoga, Inc.) sought defense and indemnity coverage from its insurers for the groundwater pollution its operations caused. The New York appellate court rejected the manufacturer's position by finding that that PFOA and PFOS squarely fell within the definition of "pollutant" within the wording of the pollution exclusions. The court held that, "regardless of whether a particular substance is specifically named as a pollutant in an insurance policy, whether a substance was understood to have a detrimental effect on the environment at the time the policy was entered into or whether pollution was an intended result" is enough to trigger the pollution exclusions at issue (*Id*. at 1096). The appellate division also found that Tonoga failed to show that the "sudden and accidental" exception to the pollution exclusion applied to restore coverage for the pollutant discharges. The court found that the discharge of PFOA and PFOS was not "sudden" in the temporal sense or accidental, because the insured had knowingly discharged those chemicals as part of its routine manufacturing processes over many years (*Id*. at 1097). The appellate division therefore found that the "sudden and accidental" exception to the pollution exclusion did not restore coverage for Tonoga's claims (*Id*).

Similarly, a federal court in Georgia recently enforced a total pollution exclusion barring a claim brought against a thermoplastics recycling facility that discharged PFAS-contaminated wastewaters into a municipal system (*Grange Ins. Co. v. Cycle-Tex Inc.*, 2022 WL 18781187 [N.D. Ga. December 5, 2022]). After receiving notice of the claim, the commercial general liability insurer agreed to defend under a reservation of rights. The insurer simultaneously brought coverage litigation and argued it had no duty to defend because the policy's "total pollution exclusion" barred coverage. The exclusion provided that there was no coverage for damage caused "in whole or in part but for the actual, alleged or threatened discharge, dispersal, seepage, migration, release or escape of pollutants at any time." (*Id*. at *1.) In ruling in favor of the insurer, the court found that there was "no doubt" PFAS were a pollutant and both the bodily injury and property damage claims fell within the exclusion. (*Id*. at *6.)

Conversely, in *Colony Ins. Co. v. Buckeye Fire Equipment Co.,* No. *3:19-cv-00534*, 2020 WL 6152381 (W.D. N.C. October 20, 2020), a manufacturer of AFFF sought defense and indemnity from its insurer for numerous AFFF lawsuits that it was facing. The suits alleged that firefighters were exposed to PFOA in a concentrated form as a result of regular contact with the company's AFFF, as well as through drinking contaminated water. The insurance policy in question contained a "hazardous materials exclusion." Based upon this exclusion, the insurer argued the policy did not cover defense of the PFOA cases because it excluded coverage for injuries "which would not have

occurred in whole or in part but for the actual, alleged, or threatened discharge, dispersal, seepage, migration, release or escape of hazardous materials at any time." (*Id*. at *2.) Under North Carolina law, however, any discharge, dispersal, release, or escape of a pollutant must be "into the environment" to trigger the exclusion (despite the lack of such wording in the policy). In other words, the exclusion barred coverage, under North Carolina law, only for "prototypical environmental harm" and not for bodily injury caused by direct exposure. (*Id*. at *4.) While the parties conceded that there was no duty to defend any of the actions that solely alleged environmental exposure, the court found the insurer did have a duty to defend the underlying cases that alleged bodily injury caused by direct exposure to the hazardous material.

These are just a few examples of how courts are interpreting pollution exclusions in the context of PFAS claims. In addition, there is a vast amount of case law involving other substances that could potentially be applied to PFAS litigation depending on the particulars of the release of PFAS in question. These cases could very well inform how a particular state may interpret how a PFAS-related exposure applies to a policy's pollution exclusion. As with *Colony Ins.*, a court might only apply an exclusion to classic environmental pollution and not to bodily injury direct exposure cases. Other courts might require a showing of an intentional release without regard to whether the release was abrupt or gradual. Yet other courts, like in *Tonoga Inc*., may apply the pollution exclusions broadly to preclude coverage for PFAS releases regardless of whether the damage is to property or person.

When does a PFAS claim trigger an insurance policy?

As noted above, PFAS-related property damage and bodily injury exposure can occur over a long period of time. Depending upon the jurisdiction, any policy in effect from the time of first PFAS exposure to the time the lawsuit is filed could potentially be implicated. In certain cases, these policies could go back several decades and may involve both occurrence-based and claims-made coverage.

Whether historical insurance policies are triggered by the PFAS claim is fact-specific and dependent on the allegations of the underlying complaint, as well as governed by the insurance coverage law in the applicable jurisdiction. In *Crum and Forster v. Chemicals Inc*., 2021 WL 3423111 (S.D. Texas August 5, 2021), a manufacturer of AFFF sought coverage under its 2011 to 2019 primary policies, which covered bodily-injury losses that "first occurred during the policy period." The policy also provided that "if the date can't be determined upon which bodily injury first occurred, it will be deemed to have occurred before the policy period." (*Id*.) As the underlying complaints were silent on when the firefighter plaintiffs were exposed or first manifested symptoms from AFFF, the insurer argued in the coverage litigation that it had no duty to defend the policyholder in the underlying lawsuits. The court rejected this argument, finding that nothing in the allegations of the underlying complaints evidenced that the dates of loss could not at some point be determined later in the litigation.

In *Wolverine World Wide, Inc. v. American Ins. Co*., 2021 WL 4841167 (S.D. Mich. October 18, 2021), a tannery sought coverage for PFAS groundwater pollution from its 1971 to 1986 occurrence-based policies. The insurers argued there was no duty to defend because the policies contained a sudden and accidental pollution exclusion that barred coverage as the underlying complaints alleged Wolverine was liable for intentional dumping and discharging chemical-laden wastes at various locations. The court held that, because the underlying complaints alleged that waste seeped, leaked, or migrated into soils and groundwater (but were otherwise silent and unclear as to whether releases were sudden and accidental), arguably the allegations included damage from both intentional and unintentional or accidental contamination. (*Id*. at *12.) On this basis the court found that a duty to defend was present at the prediscovery stage.

In both *Crum and Forster* and *Wolverine*, the complaints alleged enough facts to trigger a duty to defend under the policies at issue. However, in both cases the courts determined that coverage could be found to be lacking following a further development of the factual record regarding the date of injury and nature of the releases.

Other coverage issues

PFAS insurance claims are not straightforward and coverage is often largely dependent on the PFAS exposure details, as well as the particular policy wording at issue. For example, coverage under a pollution legal liability policy may depend on whether the PFAS was a "known pollution condition" when the policy was originally written. As discussed above, the focus on PFAS is fairly recent and historical contamination may not have been discovered by the time the policy was issued. Even if the PFAS were not a known pollutant at the time the policy was written, a future PFAS detection at a known pollution site could qualify for coverage.

PFAS exposure may also have taken place over time, potentially triggering multiple insurance policies written during different periods. Such long-tail claims have a myriad of implications for insurers. In such situations, a policyholder will likely attempt to access all of its coverage. To the extent more than one policy is triggered, the issue of policy priority becomes a key issue among the insurers. A policy's "other insurance" clause typically attempts to address this question. The terms of the other insurance clauses speak to the priority of how various triggered policies will respond. Many courts find, however, that competing "other insurance" provisions—each purporting to make its own policy excess to another—will cancel each other out (*Great Northern Ins. Co. v. Mount Vernon Fire Ins. Co.*, 92 N.Y.2d 682, 687 [N.Y. 1999]). This situation can be avoided if a policy has language that notes it is specifically excess to another policy. To the extent the policy language does not resolve the issue, the priority of multiple triggered policies is dependent on the controlling state law.

D&O liability coverage implications

Directors and officers (D&O) liability policies may also be implicated by securities lawsuits involving PFAS liabilities. Indeed, there have been notable securities lawsuits against 3M and Chemours Co., which allege, in part, that the companies failed to disclose their PFAS liability exposure and that there was a failure of management to implement processes and procedures to mitigate PFAS environmental contamination. Event-driven securities lawsuits continue to rise and, as plaintiffs' lawyers establish the playbook to bring actions against companies with PFAS liabilities, more litigation may be filed against smaller manufacturers of PFAS products and with a potential impact to their D&O coverage as a result.

INCORPORATING COVERAGE UNCERTAINTY INTO THE RESERVE ESTIMATE

The lack of clarity in how legal precedent will be applied by a particular jurisdiction is not a new concept. Despite there being decades of precedent for exposures like asbestos, the underlying policy language can still differ in unique ways that create the need for detailed coverage analysis. Emerging risks like PFAS are even more complicated, given the limited history of court rulings and lack of agreement on what constitutes a similar exposure. As such, the outcomes of coverage litigation can lead to vast differences in liability outcomes for insurers, making it difficult to produce reasonable estimates.

It is worth noting that the methodologies discussed within this paper are primarily focused on estimating the future loss payments, while future expense payments are often better estimated independently. Defense-related expenses are directly tied to policy language, as discussed above, so it makes the most sense to project these expenses alongside the loss liabilities. Other approaches involve using historical ratios of expenses to losses or a direct estimation methodology on expenses only. Additionally, expenses not related to defense costs could be ad hoc and often follow a pattern different from losses. As such, it is best to retrieve additional information about these expenses from the individual company being analyzed. With limited expense payment history for PFAS, this estimation usually needs to be incorporated directly into the coverage analysis when determining net liabilities.

For most insured accounts, coverage litigation is not strictly focused on one particular policy provision; instead, there are multiple policy provisions that could, depending on the facts, affect the coverage analysis. This uncertainty lends itself nicely to stochastic reserving approaches to provide a range of potential liability outcomes. Having the flexibility to utilize a range of assumptions in the reserving model provides insight into the true uncertainty of the estimates, which allows a company to book reserves at the appropriate confidence level.

AN EXPOSURE-BASED APPROACH TO ESTIMATING PFAS IBNR

In the absence of sufficient claims histories at the account or even industry level, actuaries must rely on a forward-looking assessment of the likely exposure of an account or set of accounts to estimate IBNER and IBNR. This process begins by drawing a map of likely exposures analogous to a flood map, where the map's geography is a web of commercial activity rather than latitude and longitude. Scientists and regulators routinely describe the commercial products and processes that expose people and environmental resources to a given hazard. In the case of PFAS, hundreds of publications consider the likelihood PFAS will migrate from particular products like grease-resistant food packaging and ski wax into air, water, household dust, and other environmental media, and how PFAS exposure in humans correlates with the use of those products.

Like a flood map, a map of commercial activity represents an inventory of latent exposures that could one day result in claims against a company and its insurance policies. Owing to the many uses of PFAS, the PFAS map is extensive. But also like a flood map, not all exposures on the PFAS map are equally prone to future claims. Producers and users of AFFF, for example, are at very high risk, while manufacturers and users of grease-resistant food packaging and ski wax are at much lower risk. The risk of any given exposure corresponds to the extent to which scientists have concluded that the exposure is material to the development of disease and the ability of claimants to demonstrate that it was their exposure to the product in question that caused their disease and not to some other product.

The science investigating PFAS exposure and disease is evolving rapidly, which implies it is not enough to consider just the relative risk of exposures today (see Figures 2-3 above). Actuaries must also consider the likelihood science will come to support a causal link between some specific exposure and some specific disease condition in the future. For example, a plaintiff may not be able to provide sufficient evidence today that their exposure to PFAS increased their susceptibility to infectious disease, but that evidence could change in coming years, opening up the possibility for new causes of action. With sufficient data on the historical evolution of scientific hypotheses, it is possible to develop a sound stochastic framework for evaluating a range of potential future outcomes. Perhaps there is only a 5% chance that science will prove strong enough to support a plaintiffs' specific claim of, say, infectious disease three years from now, but if there are many such plaintiffs, the risk is material and could be used to establish appropriately weighted IBNR estimates.

PFAS reserving is a natural fit for stochastic modeling, given the uncertainty surrounding scientific and regulatory developments, the manner in which specific companies employ PFAS in their businesses, how courts and juries evaluate scientific and economic evidence, and how insurance policies written many years ago will respond to claims. And it is now feasible to develop comprehensive inventories of PFAS exposures at the company level using structured and unstructured publicly available data and to interrogate the scientific literature at scale to develop a rigorous assessment of relative risk among those exposures. An abundance of computing power enables actuaries to run millions of simulations to fully explore the wide set of future PFAS litigation outcomes and generate central and tail estimates of account-level and portfolio-level IBNR. Developing a systematic understanding of PFAS exposures in this way can facilitate setting more accurate bulk IBNR reserves and assist with identifying accounts where buybacks or commutations would better fit the carrier's long-term risk appetite.

Conclusion: Action steps

While much is still unknown about PFAS and how they will impact insurance liabilities, the evidence suggests that there is sufficient information available to develop strategies on how to estimate reserves.

Deriving reserves for a novel risk is itself not a novel concept. Actuaries have developed and adapted methodologies to meet the challenges posed by emerging exposures for decades, and the capabilities of these methodologies continue to improve and evolve as more data becomes available. These approaches, paired with insights from external experts, can be used to develop reasonable estimates for potential PFAS liabilities today.

To the extent that a company is already booking PFAS reserves, now is the time to revisit whether there is room for enhancements to the methodology: Are the risks segmented in a reasonable manner that balances credibility with homogeneity? Should more insured account level reserve projections be considered? Are pure IBNR estimates reasonably robust and distinct from account-level IBNER? These are just a few of the considerations when assessing the current approach.

On the other hand, if this is the first time that an actuary is considering reserving for PFAS, where does one start? The actuary is at the mercy of the available data, so companies should first work to segment their PFAS claims to date and determine which accounts pose a risk for future exposure to PFAS liabilities. The actuary should also identify which experts may be well versed to provide insights on the outcomes of PFAS coverage litigation, the potential insured account-level exposures, the developing regulatory response, and ongoing scientific research.

The challenge of tackling PFAS liabilities today may seem daunting, but getting ahead of this emerging exposure provides companies with the opportunity to develop a game plan for PFAS and maximize their ability to strategize and control these exposures.

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