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# Accidents not waiting to happen

## The recent firefighting foam spill in Brunswick points to a much larger problem Maine has ignored

**By: Marina Schauffler - Tuesday December 10, 2024 3:38 am**

Rough estimates place Maine's remaining volume of firefighting foam with PFAS at upwards of 40,000 gallons. Despite a 2020 recommendation by the Governor's PFAS Task Force to

inventory and collect AFFF stocks, no progress toward that goal has been realized in nearly five years. (Photo by Brendan Bullock)

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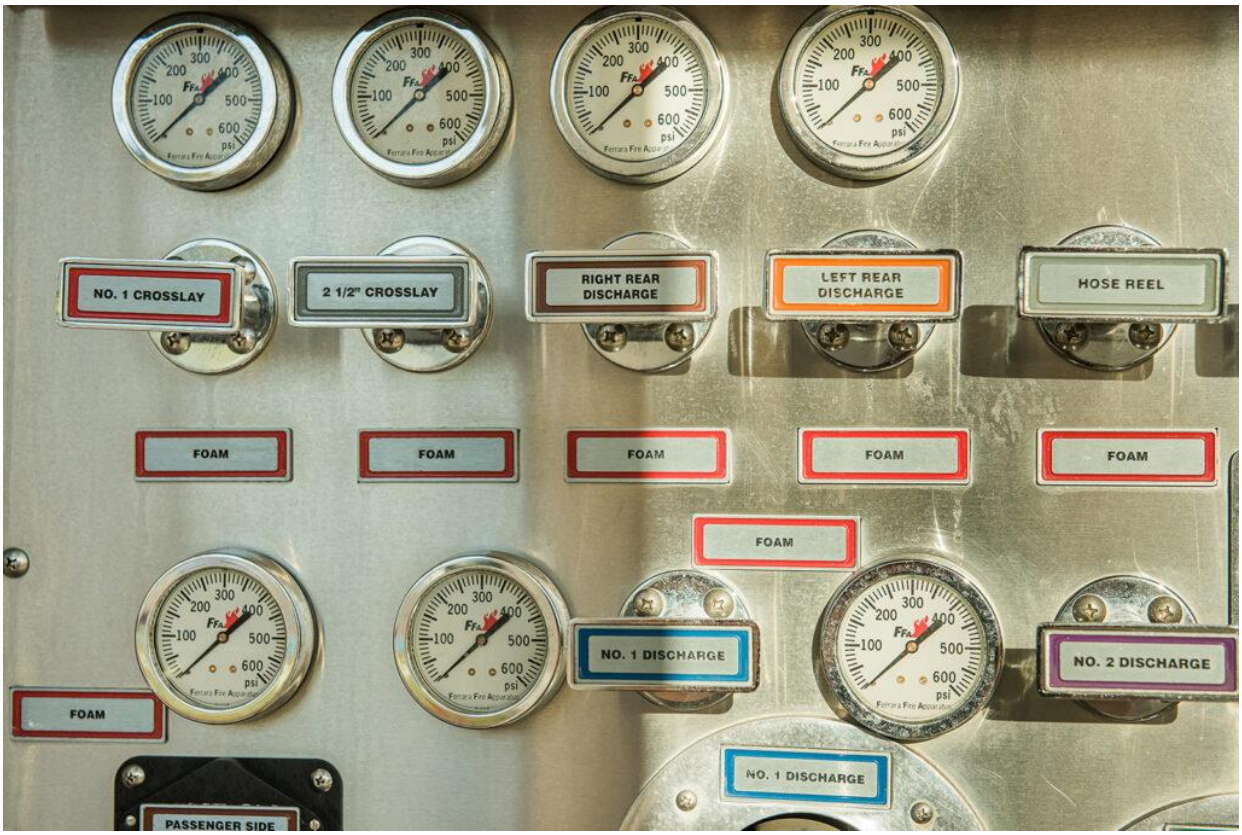
During 21 years working as a municipal firefighter, "I had hyper-exposure" to foam, recalled Jim Graves, director of training at the Maine Fire Service Institute. Graves entered the fire service at age 17 and was later sent to "foam firefighting school," a week-long training in the selection and use of these chemical fire-suppression agents.

Fires are classified by the material ignited, and only Class A fires — involving wood, cloth, rubber and some plastics — respond well to water. Class A foam is typically used on structural fires because it penetrates into materials to quell flames quickly. Class B or aqueous film-forming foam (AFFF, called "A triple-F") targets flammable and combustible fuel fires, which water can spread.

A cascading arc of AFFF, formed by mixing a small percentage of concentrate with a high volume of water, can slide quickly across the surface of a fuel spill, creating a thin barrier that effectively deprives flames of oxygen and suppresses fuel vapors. The efficiency of AFFF relies on per- and polyfluoroalkyl substances (PFAS), a vast class of thousands of synthetic chemicals characterized by nearly unbreakable carbon-fluorine bonds.

First used in World War II, PFAS were subsequently added to hundreds of types of consumer and industrial products due to the chemicals' ability to repel water and oil, resist heat, and reduce surface tension. Corporate documents reveal that chemical manufacturers like 3M and DuPont knew a half-century ago that fluorinated chemicals posed serious health risks. PFAS persist indefinitely in the environment and accumulate in bodies—potentially disrupting hormonal, immune and reproductive systems, and increasing the risk of various cancers.

AFFF became a staple on military bases in the 1970s, not long after its development by 3M and the U.S. Navy. By 1988, the federal government mandated its use at commercial airports (a stricture that held until May 2023).



Use of AFFF foam increased among Maine fire departments in the 1980s and 1990s, with 70% of departments in a recent survey reporting that prior to 2022 they used the foam, at least occasionally, primarily for combustible fuel fires, vehicle fires and routine trainings. (Photo by Brendan Bullock)

Some municipal fire departments, particularly those near highways, industry and airports, also kept stocks on hand for vehicular and other fuel fires and for use in periodic trainings. A recent survey of Maine fire departments (see sidebar) found that 70% used AFFF prior to 2022, at least occasionally, primarily for combustible fuel fires, vehicle fires and routine trainings.

When military bases in Maine closed, they gave some AFFF (made to military specifications, high in PFAS) to municipal departments around the state. “Smaller departments always had access to that ‘mil-spec’ foam,” one fire chief observed.

AFFF became a staple tool for many departments because it worked remarkably well. “It was a truly amazing chemical engineering accomplishment,” Graves said, “but horrible, as we have now learned.”

**Not ‘safe as dish soap’**

In 2001, a consultant told a technical committee of the nonprofit National Fire Protection Association (NFPA) that the toxicity and persistence of two PFAS compounds that Class B foams can degrade into — PFOA and PFOS — could be a “death warrant.”

Manufacturers changed methods to produce PFAS formulations with shorter carbon chains, and marketed those AFFF concentrates to fire departments as a “sustainable substitute.” But over

time, many of the newer compounds proved to be just as toxic, and more mobile and persistent in ecosystems.

States began to control AFFF use in 2019, and in 2021 Maine banned its manufacture, sale and distribution (temporarily exempting airports and oil terminals), and mandated containment and reporting of any use. Maine also banned AFFF in firefighter training, but through the preceding decades "we trained with foam because it was required," Graves said, referring to the voluminous standards the NFPA sets for fire departments. "If we had known, we would have stopped using [foam] way earlier."

Firefighters were assured that AFFF was safe as dish soap, and the concentrate looked similar — a pale amber liquid stored in sparsely labeled 5-gallon pails, 50-gallon drums or translucent 250- to 330-gallon totes. The concentrate could become viscous at times, congealing around valves. Graves recalls once having to reach into a tank of AFFF concentrate up to his shoulder to release a clog.

Convinced that all firefighting foams were harmless, departments used them — not only at live fires and trainings — but occasionally, when requested, for recreational purposes. Various foams (of unknown class) were spread for birthday parties and at parks for community events so that children could slide and romp in what seemed like a bubble bath run wild.


Fire departments throughout Maine and around the country did not confine foam use to live fires and trainings. Upon request, they would periodically spread foam in parks or other settings so that children could frolic in it. (Contributed photo)

Recent research indicates that some legacy PFAS compounds like PFOA and PFOS may transfer readily into aerosol form. When the State of Michigan tested foam at a highly contaminated lake,

it found PFAS levels as high as 220,000 parts per trillion (ppt). Yet little research has been done on health effects from inhaled particles of AFFF, according to a spokesperson for the National Institute for Occupational Safety and Health at the federal Centers for Disease Control and Prevention.

"For many firefighters, AFFF may be the most significant source of exposure to PFAS," a working group of the International Agency for Research on Cancer (IARC, part of the World Health Organization) concluded. In 2023, the IARC classified PFOA as carcinogenic and PFOS as possibly carcinogenic to humans.

Cancer has become the leading cause of death among active firefighters. North America's largest union of first responders, the International Association of Fire Fighters, reports that in 2023 occupational cancer accounted for 72% of the line-of-duty deaths among its U.S. members. Firefighters are 9% more likely than the general population to develop cancer and 14% more likely to die from it, a federal study found.

A fire station sign reads: "You can't train too hard for a job that can kill you." (Photo by Brendan Bullock)

Through training, appropriate equipment and careful practices, firefighters work to minimize the hazards inherent in fires, smoke and diesel truck fumes. But they were never warned that chemicals in the AFFF spewing out of firehoses and blowing about them like snow could get into nearly all of their organs and remain for years.

"It freaks me out so bad that the firefighters of Maine had no clue," Graves said. "Honestly, I'm scared for a lot of my generation." He has already lost many firefighter friends to cancer. Colleagues in the fire service share Graves' sense of being trapped in what he terms a "bad

lottery," expecting not a winning ticket but a devastating illness: "Many of us are sadly waiting for the day that we get a diagnosis."

**Risks of scattered AFFF stocks**

The threats posed by AFFF extend far beyond the fire service. "AFFF is responsible for some of the largest PFAS releases to the environment," Washington State's Department of Ecology wrote recently in a 260-page environmental impact statement. "These are also the most complex, costly, and difficult to investigate and remediate."

The longer AFFF concentrate sits at dispersed locations around Maine, Graves said, the greater the likelihood it will get spilled or dumped. Public awareness of that risk rose after a hangar fire suppression system at Brunswick Executive Airport malfunctioned last August, mixing water with roughly 1,450 gallons of PFAS-laden concentrate to fill the massive structure four to five feet deep in foam.

That spill, which could affect the community and watershed for generations, was far from anomalous. Brunswick Landing, the converted compound of a former U.S. Navy air station, has had at least a dozen other inadvertent AFFF spills recorded during and after its military use, including another hangar spill in 2019 and a 2012 hangar spill of 2,000 gallons of concentrate discovered by the Brunswick Sewer District.

The August 19 AFFF spill at Hangar 4 of Brunswick Executive Airport, the site of a former U.S. Navy air station, was one among at least a dozen other AFFF spills recorded during and after the military's tenure there. (Photo by Martha Spiess)

For 30 years ending in 1990, the former station hosted fire trainings (many of which likely involved foam discharge), according to an environmental assessment prepared for the Brunswick Armed Forces Reserve Center. The report also noted that "expired AFFF would be discharged to various grassy areas around [the Naval Air Station] from fire vehicles for routine maintenance."

In an assessment of airport fires at Department of Defense facilities nationwide, the U.S. Air Force found that just one fire had occurred over three decades (extinguished by a water deluge system) while chemical foam had discharged accidentally once every two months on average over 15 years, resulting in one death, 21 injuries and more than $24 million in "mishap" costs. Two months prior to the Brunswick accident, 800 gallons of foam concentrate spilled at an Air National Guard facility in South Burlington, Vermont.

Fire suppression systems used in oil and gas storage and transport, many of which rely on AFFF, can also malfunction. Rack systems used to transfer oil and gas from storage tanks to trucks have built-in sprinkler systems that are prone to accidents, according to Philip Selberg, chief of the South Portland Fire Department. Oil terminals are subject to Maine's AFFF law as of January 1, 2025, but to Selberg's knowledge only one local terminal has transitioned to a fluorine-free substitute. (That terminal owner, Global Partners, declined Maine Morning Star's request for an interview.)

Awareness of risks associated with AFFF has increased since the state restricted its use in 2021, but deliberate dumping of foam concentrate remains a concern. The Maine Department of Environmental Protection (DEP) has spent several years overseeing remediation of a site where intentional dumping occurred in 2020.

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21 injuries and more than $24 million in “mishap” costs. Foam from the recent Brunswick spill carried PFAS chemicals into surrounding ecosystems. (Photo by Steve Walker)

During routine well monitoring at a closed demolition debris landfill in Gorham, DEP staff learned that the town’s public works staff had dumped 500 gallons of AFFF concentrate from the fire station into the landfill several months earlier. That discovery led to a protracted investigation and remediation (with costs borne by the municipality), involving multiple environmental assessments and removal of contaminated soil, according to agency records.

AFFF can also be deployed inadvertently, due to confusion among firefighters (many of them volunteers) who face a vast and ever-changing array of foam formulations. In New Hampshire, contractors for the state recently identified about 250 AFFF formulations from roughly 40 manufacturers. Maine fire departments received clear guidance not to use AFFF in training and to report its use to the DEP, but they never got instructions on separating AFFF stocks and storing them carefully until they can be collected — to reduce chances of unintended use.

Drums of AFFF concentrate in Hangar 6 at the Brunswick Executive Airport, photographed in November 2023, date back to 1985 and 1989 according to product labels, exceeding the longest expected lifespan by roughly 15 years.(Photo courtesy of Ed Friedman/Friends of Merrymeeting Bay)

Some AFFF containers in Maine far exceed the product’s long shelf life, which ranges from 10 years to 25 years. Plastic drums of PFAS-laden concentrate stored at the Brunswick Executive Airport (as of November 2023) had production dates in the mid- to late 1980s.

**Not a simple switch**

A wide range of fluorine-free foams (called F3) are now available, and two independent entities have tested some of these products to ensure that they are not — unlike earlier PFAS reformulations — “regrettable substitutions.”

Anila Bello, a researcher with the Department of Public Health at the University of Massachusetts Lowell who surveyed fire-training facilities nationally, has observed how that earlier deception left fire professionals skeptical about current marketing claims. Having been told that shorter-chain PFAS were safe during the foam transition that occurred in the mid-2000s, "[firefighters] are very hesitant transitioning to F3 foam; they want it to be truly safe for human health and for the environment," she said. "They're concerned that they'll be in the same situation 10 or 20 years from now."

A toxicological study of six PFAS-free foams concluded that the new formulations, when compared to earlier products with PFAS, "appear to have a lower likelihood of environmental persistence and bioaccumulation and to have lower oral human health toxicity." However, the Interstate Technology Regulatory Council cautions that all Class B foams (including F3 ones) can be problematic "if the foam reaches drinking water sources, groundwater [or] surface water" with the potential for "acute aquatic toxicity" and "nutrient loading."

Even fire departments ready to adopt F3 alternatives can be slowed by the costs and the logistical hurdles of selecting appropriate foam, training staff in its use, and purging AFFF from existing equipment so it does not contaminate the new foam.

Fire departments ready to adopt F3 alternatives can be slowed by the costs and the logistical hurdles of selecting appropriate foam, training staff in its use, and purging AFFF from existing equipment so it does not contaminate the new foam. (Photo by Brendan Bullock)

In South Portland's case, the needed foam research took considerable time and expense, including sending staff members to different out-of-state product demonstrations to determine which new formulas might work best — knowledge that fire departments can't derive from

“white papers written for chemical engineers,” Selberg said: “It’s a bit of a leap of faith to be sure that what you buy is going to work for you.”

The South Portland Fire Department recently settled on a replacement foam that Selberg has confidence in, but now the department needs to coordinate with seven oil terminals, each of which is mandated to keep a reserve of AFFF on-site but all of which rely on the city for fire services. The foam that terminals select for replacements, he said, “needs to be something we as a department are familiar with so if we respond to a facility, we can all work together.”

One of the largest concentrations of AFFF still stored in Maine is in South Portland, where seven oil terminals along the Fore River are mandated to keep reserves on hand for the City’s fire department to use. Legislation that prevents oil terminals from purchasing new AFFF takes effect January 1, 2025. (Photo by Alex MacLean)

Once departments acquire F3 foams, they need to rid foam equipment of residual AFFF. That process, typically involving a series of rinses, is complicated by the need to save rinse water for safe disposal (a process outlined in detail by states like Washington and Connecticut).

Maine has no central clearinghouse for information on the foam transition so departments like South Portland’s have been fielding frequent calls since the August 19 airport hangar spill.

“Brunswick has upped the ante for everybody: I can’t tell you how many calls I’ve gotten from departments wanting to know what to swap, how to swap,” Selberg said. “Suddenly, it’s a big deal. Honestly, it should have been a big deal for us five years ago, right? Until Brunswick happened, we’ve all been sitting around waiting to figure out if someone would take the lead. And sadly, we haven’t.”

**A missed opportunity**

Five years ago, Graves and two dozen other individuals knowledgeable about Class B foam were invited to serve on an AFFF Working Group of the Governor's PFAS Task Force, which formed to develop a strategic plan for the state's PFAS response. The working group drafted recommendations, endorsed by the task force and published in January 2020, that could have set Maine on a path toward gathering and securing all remaining AFFF stocks, a step that might have prevented the Brunswick spill.

The task force recommended in part "that all fire departments in the State of Maine be required to disclose the type and quantity of current inventory of Class B AFFF," and that protocols be established for safe storage and routine inspection. It called for a state-level funding mechanism that would allow the Maine Emergency Management Agency (MEMA) and the DEP to "develop and execute a Class B AFFF takeback and/or replacement program that does not financially burden Maine fire departments or their municipalities."

The state-level funding mechanism, a prerequisite for many of the other working group recommendations, was never established. In response to inquiries from Maine Morning Star, spokespersons for MEMA and the DEP indicated that any progress toward an AFFF inventory and takeback (or buyback) program await funding. Even the mandated reporting of AFFF use is in essence "voluntary," according to DEP spokesperson David Madore, because it was an unfunded initiative. "We do not have the financial resources or staff required to implement the program," he wrote.

Fourteen states have now taken action to limit uses of AFFF, according to the nonprofit Safer States, but few states have created the sort of dedicated revenue source that the Maine task force envisioned. Funded by a tax on tanker fuel transport, Colorado helps fire departments cover foam replacement costs by buying back AFFF at $40/gallon. The tax also supports a grant program that helps public water systems, private well owners and local governments sample waters for PFAS contamination, including those affected by past AFFF use. Connecticut appropriated $3 million to help fire departments transition off fluorinated foams, providing grants for disposal of AFFF concentrate and rinsate from decontaminating trucks and equipment.

Manufacturers marketed AFFF to fire departments as being ‘safe as dish soap,’ so firefighters took few precautions handling the concentrate or the foam created when concentrate was mixed with high volumes of water. (Photo by Brendan Bullock)

Without a provision to cover municipal costs for foam replacement, budgetary pressures or the Yankee penchant to use things up before acquiring replacements could drive fire departments to retain their remaining AFFF stock. As South Portland has learned, the foam transition entails extensive labor and costs — in research, retraining and equipment cleaning — that extend beyond replacement foam purchases. Asked what the fire department would like going forward, Selberg replied: “The best-case scenario is the State comes in tomorrow and says ‘Inventory what you have, we’ll come down and get it, and we’ll credit you so you can buy what you need. Right now, that burden is going to be on our city to do all those things.”

**Determining how much AFFF is in Maine**

The AFFF Working Group discovered during its 2019 research that completing a statewide inventory would prove challenging. An initial survey sent to 305 fire departments by the Office of the State Fire Marshal garnered just 61 responses. Among 20 “industry partners” with potential AFFF (like paper mills and oil terminals), eight responded.

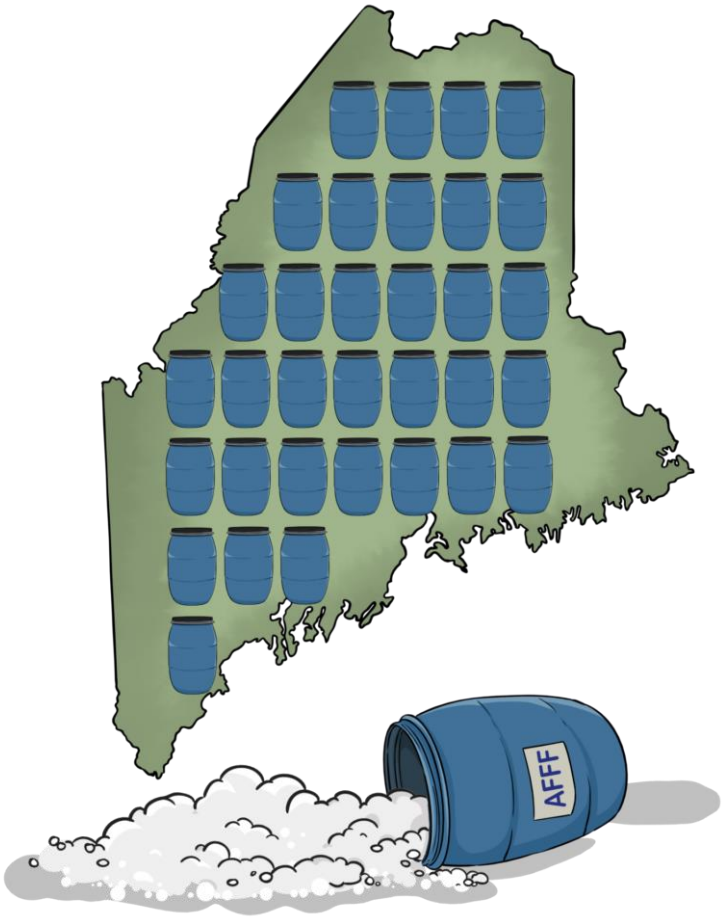
Until Brunswick happened, we’ve all been sitting around waiting to figure out if someone would take the lead. And sadly, we haven’t.

**– Philip Selberg, South Portland Fire Department chief**

Incomplete state-level data complicates the work of undertaking an inventory. Maine currently lacks a comprehensive database of all the state's fire departments, and only 259 out of an estimated 378 departments report to the state. MEMA and staff of the Fire Marshal both informed Maine Morning Star that they have no current contact information for industry partners.

As of 2022, the Maine Marine Oil Spill Contingency Plan documented more than 19,000 gallons of AFFF stored in just four communities. Former military bases represent another significant source, with an estimated 6,000 gallons of AFFF concentrate at Brunswick Landing alone (although numbers are still in dispute).

Factoring in other military sites, airports, helipads, paper mills and fire departments, AFFF accounting becomes speculative. The DEP estimated the total volume statewide in 2022 at 48,000 gallons but that was simply an extrapolation from the limited responses to the AFFF Working Group survey. A recent survey completed by Maine Morning Star, which like the state's 2019 survey had only a 20 percent response rate, reported roughly 4,000 additional gallons at municipal departments beyond those counted in the oil spill plan. A similar extrapolation, adding in the 25,000 gallons from industry and military sources, would total 45,000 gallons—close to the DEP's original estimate.




The 1,450 gallons of AFFF foam concentrate released in the recent Brunswick spill represents a small fraction of the total remaining stocks around the State. In 2022, the Maine DEP offered a rough estimate of 48,000

gallons, approximately 33 times the volume discharged in the August 19 hangar accident. (Image by Hanji Chang)

**Laying the groundwork for success in AFFF collection**

For Maine to successfully gather back most of the remaining AFFF, it will need an accurate inventory of where the foam concentrate is stored. Achieving a high response rate on an inventory is clearly challenging — but not impossible. North Carolina undertook an AFFF inventory with roughly three times the number of fire departments Maine has (1,217 departments spanning 2,119 sites, when counting multiple stations) and achieved a 100% participation rate. Brian Taylor, the State Fire Marshal, said he knows what Maine is up against, given that his office typically gets a 10% return rate on surveys and both states have a high proportion of departments staffed entirely or mostly by volunteers.

In North Carolina, Taylor said, the AFFF inventory was mandated and strongly supported with "boots on the ground" — regional resource people (affiliated with the North Carolina Collaboratory) who could help local departments compile the needed information. The state also has three "foam research analysts" to help gather and manage data, at an annual cost of roughly $300,000, according to Taylor.

North Carolina plans to conduct an annual AFFF inventory until all remaining stocks are collected, with about 11% gathered and stored by the State to date). Its foam analysts are also helping gather data for a state investigation of water quality at wells located near fire departments and training areas.

To make AFFF reporting easier, Taylor's office encouraged the development of a new application within a software system already used to report fire incidents by many fire departments nationally. That AFFF management application is now available to any state at no added cost. Use of that reporting software is mandated in North Carolina but remains optional in Maine, according to State Fire Marshal Shawn Esler. It was given to departments in 2014 and 91 percent of reporting departments in the state now use that software, according to the Fire Marshal's office.

**Getting rid of AFFF**

Following up on Maine's AFFF law, the DEP delivered a progress report to the Legislature in March 2022 that identified obstacles to disposing of the foam concentrate stocks. The primary options at that time involved incineration or transport to a hazardous waste dump.

Incineration of surplus AFFF by the Department of Defense had already generated PFAS contamination downwind of incinerators, indicating that temperatures in a typical incinerator do not fully break down PFAS (a concern confirmed by a U.S. Environmental Protection Agency guidance document last spring).

**Survey findings:**

Among the fire departments that responded to the Maine Morning Star survey

- 28% still have AFFF stocks stored on site;
- 7% report using AFFF since restrictions took effect in January 2022; and

- 13% have begun acquiring fluorine-free foams.

Transporting PFAS out of state to hazardous waste facilities in fenceline communities runs counter to the environmental justice provision Maine must apply in its own siting decisions regarding solid waste facilities. Landfills can contaminate groundwater and surface waters with PFAS from leachate and can emit PFAS in a gaseous form.

Since 2022, experimental approaches to break down AFFF into relatively benign elements have advanced, with some methods now being piloted at a commercial scale. Two states, Ohio and New Hampshire, have sent their AFFF stocks to a new plant in Columbus, Ohio that uses superheated water to break apart the strong fluorine-carbon bonds in PFAS, a process known as supercritical water oxidation (SCWO).

This highly energy-intensive process is still new and while it doesn't appear to generate problematic PFAS byproducts, it does produce hydrofluoric acid, which the EPA notes "may require protections for worker health, emission controls, and reactor care." A 2022 U.S. Government Accountability Office report noted that "maintenance can also be difficult and costly because of the intense heat, pressure and corrosive by-products generated during treatment."

New Hampshire's contract to dispose of 9,924 gallons of AFFF using SCWO is costing roughly $500,000, according to Andrew Gould of the state's Department of Environmental Services. Once the material is processed, the state will be provided per-batch confirmation of destruction to help protect the participating fire departments and airports from liability. (PFOS and PFOA are now listed as hazardous waste under the federal "Superfund" law, but the EPA has issued a policy explicitly stating that it does not intend to pursue entities such as fire departments, local airports and water utilities.)

In its 2022 report to the Legislature, the DEP indicated that it "does not recommend pursuing long-term consolidated storage of waste AFFF at this time. Until the U.S. EPA provides final guidance on management of this waste stream, the Department recommends ensuring that existing stocks of AFFF are stored safely in place." Nearly three years later, the EPA appears no closer to issuing final guidance, having just updated its "interim" guidance in April 2024.

The August foam spill at Brunswick Landing undercut public confidence that remaining AFFF stocks can or will be "stored safely in place." By mid-September, Maine Rep. Dan Ankeles (D-Brunswick) had submitted three bill titles to the Legislature, including ones that would mandate and fund both an AFFF inventory and a takeback program. Details are still being finalized in concert with the DEP and the Office of the State Fire Marshal.

 The foam spill at Brunswick Landing last August undercut public confidence in the safety of dispersed storage of AFFF stocks. (Photo by Steve Walker)

Maine could collect AFFF and store it until a thorough analysis of emerging technologies is completed. Now that oil terminals in Maine are becoming subject to the AFFF law, they will be transitioning off fluorinated foams. Staff of the South Portland Fire Department have been meeting with oil terminal representatives and are considering disposal options for the City's remaining stocks of AFFF.

"We don't have the facilities to keep it other than how we keep it," Selberg said. The department's AFFF containers are stored in climate-controlled settings, but they're not bermed off or protected with secondary containment to catch leaks. Planning for the removal and replacement of 3,000 or so gallons of foam concentrate, he adds, "the logistics and cost of that are pretty burdensome." The city recently allocated $125,000 in federal American Rescue Plan funds to begin that transition.

"I've been approached by some of the terminals here about going in with them and getting rid of [AFFF stocks] through one of the waste contractors," Selberg said, "but I don't really know where it's going. So am I just sending it to some poor county in the middle of nowhere and making it their problem?"

**Surveying fire departments**

To learn more about PFAS in and from firefighting, the nonprofit news site Maine Morning Star and the nonprofit Pulitzer Center collaborated with researchers at the Rutgers School of Health

on a survey of Maine fire departments. The lead researcher, epidemiologist Judith Graber, conducts ongoing research on firefighters in four Maine departments through a Cancer Assessment and Prevention Study, part of a national Fire Fighter Cancer Cohort Study.

The survey, conducted in cooperation with the Office of the State Fire Marshal, the Maine Fire Chiefs Association, the Maine State Federation of Firefighters and the Professional Fire Fighters of Maine, was sent out in July 2024 to 378 fire departments, with follow-up reminders. The results shared in this series reflect the 77 surveys received. (That 20 percent response rate is identical to a state survey specific to AFFF distributed in 2019.)

Given the relatively low response rate, the data shared in this series does not reflect the breadth of Maine's fire service (estimated by the Maine State Federation of Fire Fighters at around 7,200 firefighters statewide). For example, the survey has a higher proportion of departments mostly or entirely staffed by career firefighters (34 percent, rather than the 7 percent estimated in a federal fire department registry).

**Graphics and text highlights from the survey can be found here.**