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Report to Congressional Requesters

July 2024

FIREFIGHTING FOAM

DOD Is Working to Address Challenges to Transitioning to PFAS-Free Alternatives

Accessible Version

GAO-24-107322

GAO Highlights

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Highlights of GAO-24-107322, a report to congressional requesters
July 2024

FIREFIGHTING FOAM

DOD Is Working to Address Challenges to Transitioning to PFAS-Free Alternatives

Why GAO Did This Study

DOD uses AFFF in about 1,500 facilities and over 6,800 mobile assets worldwide to suppress fires. Release of AFFF into the environment, either through accidental releases, or for fire training and emergency use, has resulted in PFAS detections in drinking water and groundwater in and around DOD installations. In recent years, various statutes have been enacted to limit DOD's use of PFAS-containing materials, including AFFF.

GAO was asked to review issues related to DOD's transition to PFAS-free alternatives to AFFF. This included the extent to which DOD has (1) taken action to discontinue use of AFFF at DOD installations and (2) identified challenges that may affect its ability to meet statutory deadlines for discontinuing use of AFFF.

GAO reviewed relevant statutes and examined DOD and military department documents and policies related to use of and transition from AFFF. GAO also interviewed officials from the Office of the Assistant Secretary of Defense for Energy, Installations, and Environment; the military departments; and other agencies responsible for implementing the AFFF transition.

DOD provided technical comments on a draft of this report, which GAO incorporated as appropriate.

What GAO Found

The Department of Defense (DOD) has taken steps to eliminate use of aqueous film-forming foam (AFFF)—a product used to fight flammable liquid fires—at its installations. AFFF contains per- and polyfluoroalkyl substances (PFAS), which may have adverse effects on human health, including effects on fetal development, the immune system, and the thyroid. Also, PFAS may cause liver damage and cancer. The National Defense Authorization Act for Fiscal Year 2020 required, in part, that DOD discontinue use of AFFF at its installations after October 1, 2024—with waivers possible until October 1, 2026, and an exemption for shipboard use. The military departments have developed implementation plans, schedules, and costs for replacing AFFF in all land-based mobile assets and facilities worldwide. Further, DOD has developed specifications for the development of a fluorine-free foam that

provides a PFAS-free alternative for meeting DOD's fire extinguishing performance standards.

Firefighters Train to Extinguish Aircraft Fires

Source: U.S. Army/Patrick Hodges. | GAO-24-107322

The military departments have identified challenges that may affect the time and resources required to fully eliminate AFFF at DOD installations. For example:

- There are several compatibility issues with qualified fluorine-free foams that preclude them from being drop-in replacements for AFFF for certain tactical firefighting systems, such as their inability to withstand certain temperatures or to be mixed with water in advance of use.
- There are substantial funding requirements for the transition from AFFF to a fluorine-free product—initial estimates stand at over $2.1 billion.
- DOD firefighters are not fully trained in use of fluorine-free foams, which differs from use of AFFF.

In February 2024, DOD reported to Congress that it anticipates needing to submit the two allowable 1-year waiver requests to the October 1, 2024, statutory deadline—extending some AFFF use at DOD installations to October 1, 2026. The extensions are primarily due to the time it takes to transition systems from AFFF to fluorine-free alternatives without compromising missions or safety.

Contents

Abbreviations

AFFF Aqueous film-forming foam

PFAS	Per- and polyfluoroalkyl substances
DOD	Department of Defense
EPA	Environmental Protection Agency
NDAA	National Defense Authorization Act
ASD(EI&E)	Assistant Secretary of Defense for Energy, Installations and Environment
MILSPEC	Military specifications
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
FY	Fiscal Year

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

July 8, 2024

The Honorable Mazie K. Hirono
Chair
Subcommittee on Readiness and Management Support
Committee on Armed Services
United States Senate

The Honorable Brian Schatz
United States Senate

The Honorable Ed Case
House of Representatives

The Honorable Jill N. Tokuda
House of Representatives

Release of aqueous film-forming foam (AFFF)—a product used to fight flammable liquid fires—into the environment, either through accidental spills or releases, or for fire training and suppression, has resulted in per- and polyfluoroalkyl substances (PFAS) detections in drinking water and groundwater in and around Department of Defense (DOD) installations. According to the Environmental Protection Agency (EPA), exposure to certain PFAS may have adverse effects on human health, including effects on fetal development, the immune system, and the thyroid, and may cause liver damage and cancer. In recent years, various statutes have been enacted to limit the DOD use of PFAS-containing materials, including AFFF. Accordingly, DOD has taken steps to transition to PFAS-free firefighting alternatives, including transitioning to fluorine-free firefighting foams to replace AFFF. The National Defense Authorization Act (NDAA) for Fiscal Year 2020 required the Department of Defense to discontinue use of AFFF at its installations after October 1, 2024.[1]

You asked us to review issues related to DOD's transition to PFAS-free alternatives to AFFF. This report examines the extent to which DOD has (1) taken action to discontinue use of AFFF at DOD installations and (2)

[1]National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, §§ 322-324 (2019). The statute allows for the Secretary of Defense to grant two 1-year waivers to this deadline.

identified limitations that may affect its ability to meet statutory deadlines for discontinuing use of AFFF.

To determine the status of DOD's efforts to implement statutory requirements to discontinue use of AFFF at its installations and identify limitations that may affect implementing these statutes, we identified and reviewed relevant statutes, DOD policies, and other documentation related to use of AFFF at military installations. We interviewed officials involved with implementing the transition from AFFF to PFAS-free firefighting alternatives, including officials from the Office of the Assistant Secretary of Defense for Energy, Installations, and Environment (ASD(EI&E)); Office of the Deputy Assistant Secretary of the Navy (Environment and Mission Readiness); Office of the Deputy Assistant Secretary of the Air Force (Environment, Safety & Infrastructure); and Office of the Deputy Assistant Secretary of the Army (Installations, Energy, and Environment).

To determine the status of DOD's efforts to develop a specification for and procure fluorine-free firefighting foams, we reviewed DOD military specifications (MILSPEC) for AFFF, as well as fluorine-free firefighting foam.[2] We interviewed officials from the Naval Sea Systems Command involved with developing the DOD MILSPECs and qualifying products meeting MILSPEC requirements. We also met with officials from the Defense Logistics Agency involved with fulfilling military department orders for AFFF and fluorine-free firefighting foam.

To understand limitations and training needs of fluorine-free firefighting foams, we identified and reviewed research on the use of fluorine-free firefighting foams developed by DOD's Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program, and the Federal Aviation Administration's AFFF transition plan. As part of related work reviewing the November 2022 AFFF release at Joint Base Pearl Harbor-Hickam, we interviewed officials from the Navy Region Hawaii Federal Fire Department.

[2]MILSPEC is a general term used to describe one of many different types of technical documents used to support defense and federal acquisition under the Defense Standardization Program. These documents include defense specifications, defense standards, data item descriptions, and other federal standards and specifications. MILSPECs are a type of defense specification that is developed to ensure that products meet certain requirements.

We conducted this performance audit from March 2023 to June 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

DOD and AFFF

How Do Firefighting Foams Work?

According to the U.S. Fire Administration, firefighting foams work by forming a "blanket" over liquid fuel that acts as a barrier preventing flammable vapors from escaping the liquid. This helps both to extinguish the fire and to prevent additional ignition of vapors. The more stable and long-lasting this foam blanket is, the more effective the foam is at containing flammable vapors and ultimately extinguishing the fire.

Both AFFF and fluorine-free foams use this same approach to extinguish fires; however, according to the Naval Research Laboratory, AFFF contains PFAS-based fluorosurfactants, which creates both a film and a foam blanket that remains stable longer and is more effective than foams that do not contain PFAS.

However, due to potential adverse effects to human health and the environment, DOD and the firefighting industry are undertaking numerous efforts to find effective alternatives to AFFF.

Source: U.S. Fire Administration and U.S. Naval Research Laboratory (information; U.S. Army/Patrick Hodges (photo)). I GAO-24-107322

In 1967, a fire on the aircraft carrier USS Forrestal stationed off the coast of Vietnam resulted in the deaths of 134 service members. According to DOD, following this event, the Navy issued a MILSPEC for AFFF to be used by DOD to fight certain fire scenarios. AFFF has been the designated firefighting agent for liquid hydrocarbon-based fuel fires at military facilities and has traditionally been considered the most effective product available for suppressing fires caused by jet fuel (see sidebar). However, release of AFFF into the environment, either through accidental releases, or for fire training and emergency use, has resulted in PFAS contamination of drinking water and groundwater in and around DOD installations. Exposure to certain PFAS may have adverse health effects

according to the EPA. For more information on our prior work on DOD's efforts to address PFAS at its installations, see appendix I.

DOD uses AFFF in about 1,500 facilities and over 6,800 mobile assets worldwide, including tactical and non-tactical mobile assets.

According to DOD officials, tactical mobile assets include deployable vehicles and equipment that are mission critical such as firefighting backpacks. In addition, nontactical mobile assets, such as an installation's firetrucks, are used in support of installation or activity operations and services. For examples of mobile assets see figure 1.

Figure 1: Examples of Aqueous Film Forming Foam (AFFF) Mobile Assets

U.S. Army soldier demonstrating use of a Macaw backpack.

U.S. Navy aircraft rescue and firefighting vehicle.

Sources: U.S. Army/Sgt. T.Wilt (left) and U.S. Navy/Petty Officer 2nd Class E. Casavant (right). | GAO-24-107322

In July 2019, DOD established a PFAS Task Force, which was codified in statute in the NDAA for Fiscal Year 2022.[3] According to DOD officials, the PFAS Task Force oversees DOD's PFAS-related activities and provides strategic leadership and direction to ensure a consistent and holistic approach across DOD. The task force is comprised of the Assistant Secretary of Defense for Energy, Installations, and

[3]Pub. L. No. 117-81, § 341 (2021) (codified as amended at 10 U.S.C. § 2714).

Environment, the Assistant Secretary of Defense for Health Affairs, as well as the assistant secretaries of the Army, Navy, and Air Force with responsibility for energy, installations, and the environment.[4] One of the PFAS Task Force's focus areas is mitigating and eliminating use of AFFF on military installations through funding efforts to research, identify, and qualify an effective fluorine-free firefighting foam for procurement.

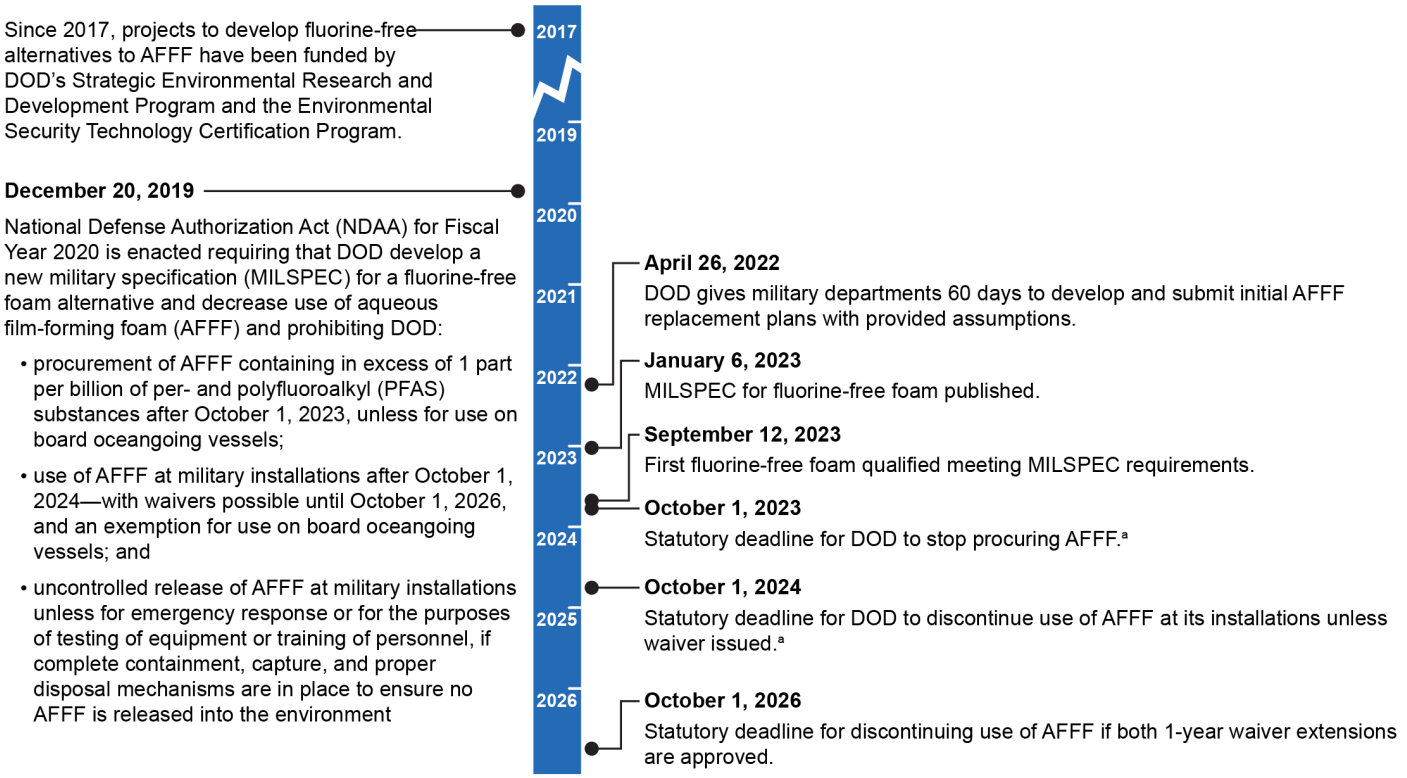
AFFF- and PFAS-Related Legislation

The National Defense Authorization Acts for Fiscal Years 2020 through 2023 established several requirements aimed at preventing and mitigating the release of AFFF at military installations while concurrently phasing out DOD use of AFFF for land-based applications, in addition to several other PFAS-related provisions.[5] See figure 2 for a timeline of key AFFF transition actions and appendix II for more information on AFFF- and PFAS-related NDAA provisions.

[4]See 10 U.S.C. § 2714(b). The Assistant Secretary of the Army for Installations, Energy, and Environment; the Assistant Secretary of the Navy for Energy, Installations, and Environment; and the Assistant Secretary of the Air Force for Installations, Environment, and Energy, respectively.

[5]National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, §§ 322-324 (2019); William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, § 318 (2021); National Defense Authorization Act for Fiscal Year 2022, Pub. L. No. 117-81, §§ 341, 343-346 (2021); and James M. Inhofe National Defense Authorization Act for Fiscal Year 2023, Pub. L. No. 117-263, §§ 345-347 (2022).

Figure 2: Timeline of Department of Defense (DOD) Aqueous Film-Forming Foam (AFFF) Transition Actions



Source: GAO analysis of select NDAA requirements and DOD actions to transition to PFAS-free firefighting alternatives. | GAO-24-107322

[a]Unless for use solely on board oceangoing vessels.

DOD Has Taken Action to Discontinue Use of AFFF at DOD Installations

DOD Has Taken Steps to Reduce Use of AFFF at Its Installations since 2016

Since 2016, ASD(EI&E) has issued guidance to the military departments aimed at reducing the use of AFFF at DOD installations. Specifically, DOD reported that in January 2016 ASD(EI&E) issued a policy requiring the DOD components to (1) issue military service-specific risk management procedures to prevent uncontrolled land-based releases of

AFFF during maintenance, testing, and training activities and (2) remove and properly dispose of AFFF containing certain PFAS from the local stored supplies for land-based use to prevent future environmental response action costs, where practical.[6]

The NDAA for Fiscal Year 2020 required that the Secretary of the Navy develop a new MILSPEC for a fluorine-free firefighting agent.[7] In January 2022, Assistant Secretary of Defense for Sustainment issued a policy, which according to DOD officials was intended to clarify the NDAA requirements and help expedite the process of developing the new MILSPEC by directing the Navy to focus the standard around certain prioritized criteria.[8] The policy directed that the MILSPEC standard:

1) establish primary performance criteria to extinguish a jet fuel fire;

2) establish secondary performance criteria to extinguish a gasoline fire; and

3) establish criteria that fluorine-free firefighting foam alternatives have similar flow properties as AFFF.

One year later in January 2023, the Navy published the MILSPEC.[9] Fluorine-free foams were commercially available at this time, but according to DOD, none existed that met DOD's fire extinguishment performance needs. According to DOD, in September 2023 DOD approved the first MILSPEC-qualified fluorine-free foam for purchase by

[6]Assistant Secretary of Defense for Energy, Installations, and Environment Memorandum, *Emerging Contaminants Governance Council (ECGC) Meeting Results* (Jan 280, 2016).

[7]Pub. L. No. 116-92, § 322 (2019). According to Navy officials the original 1969 MILSPEC was amended several times with significant changes in 2017 requiring manufacturers to produce AFFF with limits on the levels of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS)—two of the most widely produced and studied PFAS.

[8]Assistant Secretary of Defense for Sustainment Memorandum, *Fuel Type and Viscosity Requirements in New Military Specification for Per- and Polyfluoroalkyl Substances–Free Firefighting Agents* (Jan. 19, 2022).

[9]Commander, Naval Sea Systems Command, Military Performance Specification MIL-PRF-32725, *Fire Extinguishing Agent, Fluorine-Free Foam (F3) Liquid Concentrate, for Land-Based, Fresh Water Applications*, (Jan. 6, 2023).

the military departments.[10] According to DOD officials, in February 2024 a foam produced by a second manufacturer was also MILSPEC-qualified and made available for purchase.

The NDAA for Fiscal Year 2020 also established a prohibition on using AFFF for training personnel or for testing equipment unless there are complete containment, capture, and proper disposal mechanisms in place to ensure no AFFF is released into the environment.[11] In September 2020, Assistant Secretary of Defense for Sustainment issued its initial policy directing the military departments to discontinue testing and training in accordance with the NDAA requirements.[12] In April 2022, ASD(EI&E) updated this policy to implement new requirements from the NDAA for Fiscal Year 2021 by requiring military departments to report any AFFF usage or spill above specified thresholds.[13]

ASD(EI&E) Has Required Military Departments to Develop Plans for Discontinuing Use of AFFF at Installations

ASD(EI&E) issued a policy in April 2022 requiring the military departments to develop implementation plans, schedules, and costs for

[10]Qualification is an approval process completed in advance of, and independent of, a purchase (acquisition) through which a vendor's capabilities, products, and/or processes are examined, tested, and approved to be in conformance with specification requirements. Products that pass qualification tests and evaluations associated with a specification are subsequently approved for inclusion on a Qualified Products List or Qualified Manufacturers List, which are part of the Qualified Products Database, hosted by the Defense Logistics Agency. Products must qualify initially and be re-qualified periodically. Re-qualification may also be required at any time if a product formula, materials, manufacturing process, or manufacturing facility changes.

[11]Specifically, section 323 required the Secretary of Defense to prohibit the uncontrolled release of AFFF at military installations, with certain exceptions, including non-emergency release of AFFF for the purposes of testing equipment or training personnel, if complete containment, capture, and proper disposal mechanisms are in place to ensure no AFFF is released into the environment. Section 324 required the Secretary to prohibit the use of AFFF for training exercises generally. Pub. L. No. 116-92, §§ 323-324.

[12]Assistant Secretary of Defense for Sustainment Memorandum, *Prohibition of Testing and Training with Fluorinated Aqueous Film Forming Foam* (Sept. 18, 2020).

[13]Assistant Secretary of Defense for Energy, Installations, and Environment Memorandum, *Response and Reporting of Aqueous Film Forming Foam Usage, and Accidental Releases/Spills on Military Installations and National Guard Facilities* (Apr. 7, 2022).

replacing AFFF in all land-based mobile assets and facilities worldwide.[14] This policy included planning assumptions the military departments should use in developing implementation plans. According to DOD officials, the initial assumptions may be subject to change as the AFFF transition progresses, and in March 2023 DOD updated these assumptions.[15] Table 1 includes the initial assumptions and any related updates.

[14]Assistant Secretary of Defense for Energy, Installations, and Environment Memorandum, *Component Plans for Replacing Aqueous Film-Forming Foam in Shore-Based Mobile Assets and Facilities* (Apr. 26, 2022).

[15]Assistant Secretary of Defense for Environment and Energy Resilience Memorandum, *Installation-Specific Plans for Replacing Aqueous Film-Forming Foam in Land-Based Facilities and Mobile Assets* (Mar. 22, 2023).

Table 1: Department of Defense (DOD) April 2022 Planning Assumptions for Discontinuing Use of Aqueous Film-Forming Foam (AFFF) and March 2023 Updated Planning Assumptions

Issue	Planning assumption
Use of existing systems	• Qualified per- and polyfluoroalkyl substances (PFAS) free foams will be "drop-in" replacements for AFFF (similar viscosity), so no modifications will be required to existing systems (e.g., nozzles, proportioner plates, sprinkler heads). • *Updated to assumption that only minor modifications to existing systems will be needed. Some exceptions can be made for systems that are not compatible with fluorine-free foams.* • Single rinse of AFFF from existing systems will be sufficient[a]

Product and funding availability	• Qualified fluorine-free foams will be available for purchase no later than May 2023, and suppliers will be ready to *meet DOD demand.*
	  • *Updated* to August 2023.
	• DOD will be able to fund the purchase of fluorine-free foam in quantities sufficient to replace the complete inventory of AFFF, and to dispose of AFFF and related rinsate.
	• Contracts to buy fluorine-free foam, replace AFFF, and dispose of wastes will be ready no later than May 2023.
	  • *Updated to require military departments to provide details on specific contract vehicles in the narrative and the assumption that contracts would be identified by September 2023.*
	  • *Updated to require all costs associated with transition from AFFF should be included in budget requests. Funding requests should include costs associated with purchase of the replacement product, any necessary modifications required to install the alternative project, removal and disposal of AFFF, storage of AFFF waste materials, and any additional costs to support change out activities.*

Firefighter training	• Training using a fuel pool fire will be required to prepare firefighters to effectively employ fluorine-free foams. • *Updated to require implementation plans include discussion of training requirements in narrative summary.*
AFFF disposal	• Solidification and landfilling will be the disposal method. • *Updated to clarify that disposal methods outside the United States will follow host nation laws for each location.*

Source: GAO summary of DOD information. I GAO-24-107322

[a]When replacing firefighting foam, systems must be rinsed to ensure compatibility with fluorine-free foams. As a result, rinse water used in this process contains residual PFAS, and its containment and disposal must be managed. According to DOD officials, in previous transitions from legacy AFFF to the current AFFF with reduced levels of PFAS, the miliary departments rinsed their systems multiple times to remove legacy AFFF residuals. According to officials, current research indicated that multiple rinses show minimal benefit over single rinsing in regard to how much residual PFAS are left in the system but does create significantly more wastewater that has to be properly disposed. Therefore, to reduce the amount of PFAS-containing wastewater, DOD is currently assuming a single rinse will be sufficient.

Military department plans must include information about five priority lines of effort: (1) purchase of fluorine-free product; (2) removal of AFFF from mobile assets and replace with fluorine-free product; (3) removal of AFFF from facilities and provide alternative capability; (4) disposal of AFFF; and (5) training firefighters to effectively employ new fluorine-free products. ASD(EI&E) also directed the military departments to provide updates at regular intervals, but no less than quarterly. The military departments

have developed initial plans and have provided ASD(EI&E) with quarterly updates. According to DOD officials, the military departments have addressed and reflected any changes to the assumptions in their quarterly updates.

DOD Has Identified and Is Taking Steps to Address Challenges That May Hamper Its Ability to Discontinue Use of AFFF

DOD Has Identified Challenges to Discontinuing Use of AFFF at Its Installations

ASD(EI&E) and the military departments have identified challenges that may affect the time and resources required to fully eliminate AFFF at DOD installations, including three key factors—(1) fluorine-free foams are not "drop-in" replacements for AFFF in all cases; (2) AFFF transition has significant funding requirements; and (3) DOD firefighters are not fully trained in use of fluorine-free foams.

Fluorine-Free Foams Are Not Always "Drop-In" Replacements for AFFF

According to DOD, there are several compatibility issues with MILSPEC-qualified fluorine-free foams that preclude them from being drop-in replacements for AFFF for certain tactical firefighting systems. In a February 2024 report to Congress, DOD stated that while the MILSPEC-qualified fluorine-free foams are compatible with most mobile assets and fixed facility systems, certain tactical assets are not compatible with these foams.[16] For example, certain tactical assets require that foam concentrate is premixed with water; however, fluorine-free foam concentrates cannot be premixed before use. Additionally, according to DOD officials, certain assets require a foam that can withstand extraordinarily hot or cold temperatures; however, the fluorine-free foam MILSPEC does not include a requirement to meet this temperature range

[16]Office of the Under Secretary of Defense for Acquisition and Sustainment, *Department of Defense, Plan to Transition to a Fluorine-Free Firefighting Agent Pursuant to Section 322(a) of the National Defense Authorization Act for Fiscal Year 2020 (Public Law 116-92)* (Feb. 26, 2024).

and therefore the MILSPEC-qualified products cannot be used in assets operating in certain temperature ranges.

DOD's report went on to state that due to these limitations, it anticipates that completing the transition of these systems within the required time frame will be a challenge. For example, Army plans state that fluorine-free foams do not meet the operational capability requirements for its tactical assets that require firefighting foam concentrate to be premixed with water. Furthermore, Army officials noted that MILSPEC-qualified fluorine-free foams do not have a requirement to be able to be mixed with saltwater; however, in many of the locations where tactical assets are used, fresh water is not readily available. Therefore, the Army currently plans to only replace AFFF with MILSPEC-qualified fluorine-free foams in facilities and non-tactical assets. According to ASD(EI&E) officials, the Army is investigating whether other commercially available fluorine-free firefighting products exist to meet operational capability requirements for tactical assets. However, the Army cannot ensure that the development and use of a fluorine-free firefighting product that can be used in tactical assets will be completed in time to meet the transition deadline—to include the two 1-year extensions until October 2026. According to ASD(EI&E) officials, if the Army cannot find a fluorine-free foam for its tactical assets by October 2026, it will have to stop using these assets until a solution can be identified.

AFFF Transition Has Significant Funding Requirements

In February 2024, DOD reported that there are substantial funding requirements for the transition from AFFF to a fluorine-free product. These costs include the procurement of the replacement product, the limited available options for disposal of AFFF, necessary modifications of systems, any identified maintenance or repairs needed for a system to accept the new product, and disposal of AFFF and residual AFFF contained in water used to rinse systems. DOD noted that total cost estimates are still in development, and while congressional support dedicated to the transition from AFFF has allowed DOD to award contracts to initiate the transition, additional funding will be needed by the military departments. DOD has reported that these additional costs are still being assessed and may include costs for

- the establishment of adequate training facilities for firefighters to perform live-firefighting training with the new products;

- the research and development of additional fluorine-free firefighting products for tactical assets whose systems are currently incompatible with the current MILSPEC-qualified foams; and
- necessary equipment modifications for both fixed and mobile assets.

Table 2 provides estimated funding requirements by military department, as of December 2023.

Table 2: Aqueous Film-Forming Foam Replacement (AFFF) Estimated Funding Requirements by Military Department, as of Dec. 2023

	Fiscal year 2024	Fiscal year 2025 and beyond
Army	$102,043,000	$355,370,000
Navy and Marine Corps	$147,900,000	$964,800,000
Air Force	$41,000,000	$546,100,000
Total	$290,943,000	$1,866,270,000

Source: Office of the Under Secretary of Defense for Acquisition and Sustainment, *Department of Defense Plan to Transition to a Fluorine-Free Firefighting Agent* (Feb. 2024). I GAO-24-107322

Note: DOD based these estimates on information and assumptions as of December 2023, and will change as additional information is collected throughout the transition. These estimates include costs associated with (1) the removal and disposal of AFFF for facilities, non-tactical mobile assets, and some tactical mobile assets, (2) the procurement and installation of the new fluorine-free product for facilities, non-tactical mobile assets, and some tactical mobile assets, and (3) necessary facility modifications or repairs to convert the existing fire suppression system to a system that utilizes fluorine-free products or another alternative such as water only.

There are additional factors that may affect the cost of transition. For example:

- Per unit cost of MILSPEC-qualified fluorine-free foams is higher than per-unit cost of AFFF. According to DOD officials, a 5-gallon bucket of fluorine-free foam costs 21 percent more than AFFF ($183.00 versus $151.00 per gallon), and 55-gallon drums of the foam are 16 percent more than AFFF ($1,908.00 versus $1,650.00 per drum). DOD officials told us they were hesitant to enter into long-term purchase contracts with fluorine-free foam manufacturers at these prices. Officials anticipate it will take approximately 2 years before supply and demand and product costs stabilize and DOD will be positioned to enter into these long-term contracts.
- Unlike MILSPEC AFFF, fluorine-free foams from different manufacturers cannot be mixed together in individual fire suppression systems. Additionally, there are rinsing and disposal costs incurred when switching a system to a new foam. Therefore, if a military installation has purchased a foam for a fire suppression system from one manufacturer, it may not easily be able to transition its systems to a less expensive foam, were one to come available.

- DOD testing has found that more units of fluorine-free foam are required to extinguish a fire than AFFF. However, not all AFFF fire suppression systems will be transitioned to fluorine-free foam, which may help offset the amount of fluorine-free foam the military departments need to purchase. Specifically, the Air Force plans to eliminate the use of all fire suppressant foams and transition to water suppression systems in most of its aircraft hangars. The Air Force conducted a risk assessment and determined that water-only fire suppression systems in hangars, along with other fire mitigation measures, do not put service members or facilities at greater risk than foam-based fire suppression systems. Similarly, the Navy plans to transition to non-foam fire suppression systems in most Navy aircraft hangars.

Firefighters Are Not Fully Trained in Use of Fluorine-Free Foam

Studies conducted by the Office of Naval Research and the Federal Aviation Administration indicate that the techniques to extinguish a fire with fluorine-free foams differ from techniques used with AFFF, and adequate training is paramount to firefighter safety. In 2016 DOD issued initial restrictions on the use of AFFF in uncontained live fire training, and in accordance with the NDAA for Fiscal Year 2020, DOD updated these restrictions in September 2020 and in April 2022.[17]

In February 2024, DOD reported that it is currently assessing the costs, benefits, timeline, and resource requirements to meet firefighting training requirements, including refurbishing legacy firefighting training facilities or building new facilities. In May 2024, ASD(EI&E) issued guidance for the management of fluorine-free foams when used for emergency response, when there is an accidental release, and to establish guidance on the training with fluorine-free agents, but does not establish any DOD-wide training requirements. Instead, they will rely on each of the military departments to develop its own firefighter training requirements. Officials also noted that there are industry training programs that the military

[17]Assistant Secretary of Defense for Energy, Installations, and Environment Memorandum, *Emerging Contaminants Governance Council (ECGC) Meeting Results* (Jan. 28, 2016). Assistant Secretary of Defense for Sustainment Memorandum, *Prohibition of Testing and Training with Aqueous Film Forming Foam* (Sept. 18, 2020). Rescinded and replaced by Assistant Secretary of Defense for Energy, Installations, and Environment Memorandum, *Response and Reporting of Aqueous Film Forming Foam Usage, and Accidental Releases/Spills on Military Installations and National Guard Facilities* (Apr. 7, 2022).

departments could send their firefighters to for training with fluorine-free foams.

DOD Is Exploring Options to Address Transition Challenges

According to ASD(EI&E) officials, they are currently working to identify and assess all the challenges for replacing AFFF. Further, ASD(EI&E) officials have required the military departments to provide information in their quarterly implementation plan updates on any issues they anticipate will impact their ability to meet NDAA statutory requirements. Specifically, the military departments must provide their strategy for transitioning assets that are not compatible with MILSPEC-qualified fluorine-free foams. They must also report on assets that will be phased-out and assets that will be transitioning to other PFAS-free firefighting alternatives. Based on information reported by the military departments, ASD(EI&E) then requests additional follow-up information. Military departments are also asked to describe plans to train firefighters to employ fluorine-free firefighting foams, explain assumptions made on the type of firefighting training needed (e.g., location and type), and identify concerns or limitations on the training currently available. According to ASD(EI&E) officials, military departments brief the PFAS Task Force on their quarterly updates and provide follow-up information to the task force and OSD as requested.

According to Navy officials, other solutions DOD is exploring include using commercially available fluorine-free foams that can meet the performance requirements of assets that are not compatible with MILSPEC-qualified fluorine-free foams. Officials said they do not have plans to develop a new MILSPEC to solicit products compatible with these assets or to qualify these additional products, but the military departments are not precluded from using these commercially available products in assets that are not required to use MILSPEC-qualified products. They noted this practice has already been in use for systems that are designed to combat certain chemical fires that require an alcohol resistant foam firefighting agent.[18]

[18]MILSPEC qualified AFFF could not be used in these systems due to performance limitations, therefore military departments have been using other commercial foams for these systems. Officials noted that these foams do contain PFAS, and DOD will have to work to find fluorine-free alternatives for them before statutory deadlines.

In its February 2024 report to Congress, DOD reported that it anticipates the need to submit the two allowable 1-year waiver requests to the October 1, 2024, statutory deadline—extending some DOD AFFF use at installations to October 1, 2026. The extensions are primarily due to the time it takes to transition systems from AFFF to fluorine-free alternatives without compromising missions or safety. Furthermore, DOD expressed concern that as other agencies, airports, and industry have stated that they will also be transitioning from AFFF to a MILSPEC-qualified fluorine-free foam, a surge in demand, coupled with a limited number of qualified products and production capacity limits, adds a level of unpredictability for product availability that may affect DOD's transition schedule.

During this time, DOD reported that it will continue to support and fund projects through its research and development programs and collaboration with industry. Research and development projects are in progress, and several show effectiveness at laboratory and field scale. DOD reported that it is working to identify alternatives for assets and equipment that currently use AFFF and are not compatible with the new fluorine-free formulations. However, ASD(EI&E) officials said that if they cannot meet these timelines, they may need to stop use of these assets or seek congressional exemptions for the use of AFFF in certain assets. Even with exemptions, because DOD is prohibited from procuring AFFF for shore-based systems, systems that currently use AFFF will no longer be available for use once existing supplies of AFFF are depleted.[19]

Agency Comments

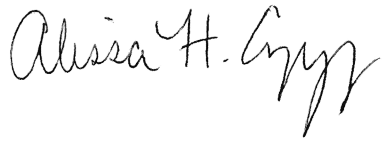
We provided a draft of this report to the Department of Defense for review and comment. DOD did not provide formal comments but provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees and the Secretary of Defense. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3058 or CzyzA@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last

[19]*See* Pub. L. No. 116-92, § 322(b), (d).

page of this report. GAO staff who made key contributions to this report are listed in appendix III.



Alissa H. Czyz
Director, Defense Capabilities and Management

Appendix I: Overview of GAO Work on Per- and Polyfluoroalkyl Substances (PFAS)

Since 2017, we have conducted several reviews related to the Department of Defense's (DOD) efforts to address PFAS at its installations. Specifically:

- **Possible PFAS contamination at Joint Base Pearl Harbor-Hickam.** In April 2024, we reported on Navy efforts to address PFAS at Joint Base Pearl Harbor-Hickam.[1] After an accidental aqueous film-forming foam (AFFF) release at the installation, DOD took immediate actions to prevent PFAS contamination. We also reported on the status of DOD's environmental restoration program to address PFAS contamination from historic use of AFFF on the installation. DOD also took steps to prepare for the Environmental Protection Agency's (EPA) National Primary Drinking Water Regulation, which was issued on April 10, 2024, and established allowable limits of certain PFAS in drinking water. We did not have recommendations in this report.
- **Implementation of prohibition on procurement of PFAS.** In April 2023, we reported that DOD had taken some steps to implement the National Defense Authorization Act for Fiscal Year 2021 prohibitions on procurement of items containing PFAS, including updating procurement policy for contracting officers and guidance for procurement of goods by government purchase cards.[2] However, we found that DOD (1) faced challenges because there was no federal law requiring items to be labeled as containing PFAS and there were no EPA-validated methods to detect PFAS in products; (2) had not assessed how to prevent military exchanges from procuring and reselling certain goods that could contain PFAS; and (3) had not updated its sustainable procurement guidance to reflect statutory prohibitions. As a result, DOD was at risk of continuing to procure items that contain certain statutorily prohibited PFAS. We made a

[1]GAO, *Persistent Chemicals: Navy Efforts to Address PFAS at Joint Base Pearl Harbor-Hickam*, GAO-24-106812 (Washington, D.C.: April 15, 2024).

[2]GAO, *Persistent Chemicals: Actions Needed to Improve DOD's Ability to Prevent the Procurement of Items Containing PFAS*, GAO-23-105982 (Washington, D.C.: April 26, 2023).

matter for congressional consideration to align the item categories specified in the April 2023 prohibition with EPA information. We also made two recommendations to DOD to develop an approach for applying the April 2023 prohibition to the military exchanges and to update its sustainable procurement guidance. DOD concurred with these recommendations. As of March 2024, the matter for congressional consideration and two recommendations remain open.

- **Actions to address PFAS overview.** In September 2023, we issued a report that provided an overview of actions that could be taken to better detect PFAS occurrence in drinking water, limit human exposure to PFAS, and treat PFAS **contamination.**[3]
- **DOD's Environmental Restoration Program.** In June 2021, we reported that DOD had taken actions to begin the process of environmental restoration at or near installations with a known or suspected release of certain PFAS and estimating costs for this process.[4] DOD had also begun to identify potential fluorine-free foam candidates; however, we found that none had been able to fully meet DOD's performance requirements. We recommended DOD annually include cost estimates for future PFAS investigation and cleanup—including their scope and any limitations—in the environmental report to Congress. DOD concurred with this recommendation and has implemented it.
- **Drinking water and elevated levels of PFAS.** In October 2017, we reported that DOD had taken action, at times in response to EPA and state orders, to address elevated levels of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS)—the two of the most widely used PFAS—in drinking water at or near military installations (e.g., by shutting down drinking water wells, providing alternative drinking water, or installing treatment systems).[5] We made five recommendations to improve DOD's reporting and use of data on compliance with health-based drinking water regulations. DOD

[3]GAO, *Persistent Chemicals: Detecting, Limiting Exposure To, and Treating PFAS Contamination*, GAO-23-106970 (Washington, D.C.: Sept. 27, 2023).

[4]GAO, *Firefighting Foam Chemicals: DOD Is Investigating PFAS and Responding to Contamination but Should Report More Cost Information,* GAO-21-421 (Washington, D.C.: June 22, 2021).

[5]GAO, *Drinking Water: DOD Has Acted on Some Emerging Contaminants but Should Improve Internal Reporting on Regulatory Compliance,* GAO-18-78 (Washington, D.C.: Oct. 18, 2017).

concurred with the recommendations and has implemented all of them.

We have also reported on other federal actions related to PFAS.

- **PFAS-related technologies.** In July 2022, we reported on challenges with PFAS assessment, detection, and treatment technologies.[6] We developed three policy options that could help mitigate these challenges—promoting PFAS research, expanding development of PFAS detection methods, and supporting full-scale disposal and destruction treatments. These policy options involved possible actions by policymakers, which may include Congress, federal agencies, state and local governments, academia, and industry.
- **Demographics of communities with PFAS-contaminated drinking water.** In September 2022, we reported that some states were setting more stringent standards for PFAS contamination in drinking water than the EPA's 2016 lifetime health advisory levels.[7] We examined six selected states where at least 18 percent of the states' 5,300 total water systems had at least two PFAS detected above EPA's 2022 interim revised health advisory levels. We found that EPA did not have information to determine the extent to which disadvantaged communities are exposed to PFAS in drinking water nationally. We recommended that EPA conduct a nationwide analysis using comprehensive data to determine the demographic characteristics of communities with PFAS in their drinking water. EPA concurred with the recommendation; however, as of May 2024, EPA has not implemented it.
- **EPA actions to regulate PFAS.** In January 2021, we reported that EPA had completed some regulatory-related actions for addressing PFAS that were outlined in the agency's PFAS Action Plan, and that other actions were ongoing.[8] For example, we reported that EPA had announced a preliminary regulatory determination to regulate PFOA

[6]GAO, *Persistent Chemicals: Technologies for PFAS Assessment, Detection, and Treatment,* GAO-22-105088 (Washington, D.C.: July 28, 2022).

[7]GAO, *Persistent Chemicals: EPA Should Use New Data to Analyze the Demographics of Communities with PFAS in Their Drinking Water*, GAO-22-105135 (Washington, D.C.: Sept. 30, 2022).

[8]GAO, *Man-Made Chemicals and Potential Health Risks: EPA Has Completed Some Regulatory-Related Actions for PFAS*, GAO-21-37 (Washington, D.C.: Jan. 27, 2021).

and PFOS under the Safe Drinking Water Act.[9] In addition, we found that EPA had not designated PFOA and PFOS as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act—doing so would allow EPA to require responsible parties to respond to a release of either contaminant and would make them liable for the costs of response actions—but planned to continue the regulatory process for such designation. We did not have recommendations in this report.

- **Toxic chemicals and chemical safety.** In March 2013, we reported that EPA had made progress implementing its new approach to managing toxic chemicals under its existing Toxic Substances Control Act authority; particularly by increasing efforts to obtain chemical toxicity and exposure data and initiating chemical risk assessments.[10] However, it was unclear whether EPA's new approach to managing chemicals within its existing Toxic Substances Control Act authorities would position the agency to achieve its goal of ensuring the safety of chemicals. Consequently, EPA could be investing valuable resources, time, and effort without being certain that its efforts would bring the agency closer to achieving its goal of ensuring the safety of chemicals. We recommended that EPA develop strategies that addressed challenges impeding its ability to ensure chemical safety and identified the resources needed to so. EPA neither agreed nor disagreed with our recommendations. EPA has implemented both recommendations.

[9]A regulatory determination is a decision about whether or not to begin the process to propose and promulgate a national primary drinking water regulation for an unregulated contaminant.

[10]GAO, *Toxic Substance: EPA Has Increased Efforts to Assess and Control Chemicals but Could Strengthen Its Approach*, GAO-13-249 (Washington, D.C.: Mar. 22, 2013).

Appendix II: Select Per- and Polyfluoroalkyl Substances (PFAS) Related National Defense Authorization Act (NDAA) Requirements

Fiscal year (FY)	Requirements

FY 2020	• Secretary of the Navy shall publish a military specification (MILSPEC) for a PFAS-free firefighting agent by January 2023 (Sec. 322)
	• By October 1, 2023 (Sec. 322):
	  • Ensure PFAS-free firefighting foam available to all military installations.
	  • Stop procurement of aqueous film-forming foam (AFFF) (except for use solely on board oceangoing ships).
	  • Submit report on AFFF transition to Congress.
	• Prohibition on use of AFFF at land-based military installations after October 1, 2024 (Sec. 322).
	  • Exemption for use of AFFF on board oceangoing ships
	  • DOD may apply for up to two yearlong waivers, which extend to 2026.
	• Prohibition on use of AFFF for training exercises at military installations (Sec. 324).
	• Prohibition on uncontrolled release of AFFF at military installations, with certain exceptions (Sec. 323):
	  • AFFF can be released for emergency response purposes.
	  • AFFF can be released during testing or training, if certain containment, capture, and disposal mechanisms are in place.

FY 2021	• Prohibits DOD from purchasing items in four categories after April 2023 if they contain certain PFAS (Sec. 333). • DOD must report to the House Armed Services Committee and Senate Armed Services Committee on the usage or release of AFFF within 48 hours, if over an established threshold (Sec. 318(a)).[a] • DOD must provide the House Armed Services Committee and Senate Armed Services Committee with an action plan on steps to clean up spill and coordination with local and state environmental regulators no later than 60 days after notification (Sec. 318(a)).
FY 2022	• Temporary prohibition on incineration of certain AFFF and PFAS; lifted when DOD issues specified guidance (Sec. 343(a)). • DOD shall conduct a review of efforts to prevent or mitigate spills of AFFF (Sec. 344(a)). • DOD shall issue guidance on prevention and mitigation of AFFF spills (Sec. 344(b)). • DOD shall publicly disclose results of testing for PFAS at areas covered by DOD no later than 20 days after receipt (Sec. 345(a)).

Fiscal year (FY)	Requirements

FY 2023	• Prohibition on purchasing covered personal protective firefighting equipment after October 1, 2026, if it contains intentionally added PFAS and protective substitutes are available (Sec. 345).
	• DOD shall submit an annual report to the congressional defense committees on PFAS contamination at military installations from sources other than AFFF (Sec. 346).
	• DOD shall submit a report to the House Armed Services Committee and Senate Armed Services Committee on critical PFAS uses no later than June 1, 2023 (Sec. 347).
	• DOD shall provide annual briefings to the House Armed Services Committee and Senate Armed Services Committee, which include the following (Sec. 347):
	  • Steps taken to identify procured items that contain PFAS and those that do not.
	  • Steps already taken and intended actions to limit the procurement of covered items that contain PFAS.

FY 2024	• DOD shall submit an annual budget justification document for funding related to PFAS (Sec. 332).

Source: GAO review of select NDAA requirements. I GAO-24-107322

[a]The established threshold is 10 gallons of concentrate or 300 gallons of mixed foam.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Alissa H. Czyz, (202) 512-3058 or CzyzA@gao.gov

Staff Acknowledgments

In addition to the contact named above, Gina Hoffman (Assistant Director), Tida Barakat Reveley (Analyst-in-Charge), Nicole Ashby, Taylin Bower, Amie Lesser, Felicia Lopez, Michael Silver, Ian Toller-Clark, and Theologos Voudouris made key contributions to this report.

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