WHITE PAPER

Navigating AFFF Conversions and PFAS Cleanup at Airports

By Kinsey Greer and Emily Pulcher, PE

New regulations are present in some jurisdictions that would restrict or bar the use of aqueous film-forming foam (AFFF) containing intentionally added per- and polyfluoroalkyl substances (PFAS) for fire suppression at airports. Airlines and airports are converting the fire suppression systems at aircraft hangars and other aviation facilities from AFFF. Some airports and airlines have also begun to investigate sites and remediate soil and water impacted by years of AFFF use.

When fires involve jet fuel — including Jet A and avgas — airlines, airports and other aviation facilities have long relied on AFFF to suppress them rapidly. Industrial manufacturers, refineries, and oil and gas terminals have also used this firefighting foam on flammable and combustible liquid fires. AFFF is valued for its ability to form a film between the fuel and oxygen which, when maintained, prevents reignition.

However, the use of AFFF is being phased out due to growing concerns about the long-term impacts of its key ingredients on human health and the environment. It contains perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), which are both water-soluble PFAS that, left unaddressed, can persist and accumulate in the environment.

State Regulations Driving Changes

In the years ahead, AFFF will be replaced with alternatives that do not intentionally contain added PFAS to mitigate environmental concerns. For now, the Federal Aviation Administration (FAA) still allows AFFF use. However, the FAA has provided guidance for the transfer of firefighting equipment to a military specification (MIL-SPEC) Fluorine-Free Foam (F3) in aircraft rescue and firefighting (ARFF) units. Some airlines and airports are not waiting for FAA regulatory requirements to transition their systems to the newly approved foams.

The motivation to transition is a result of state and local regulations that govern the use of AFFF in fixed fire suppression systems. Some airlines and airports are choosing to convert fire suppression systems and fire trucks sooner rather than later due to the decreasing availability of AFFF foams as well as the liability and expense of continuing the use of these foams in a state where it is barred. Industry changes and a desire to future-proof facilities are also driving fire suppression system conversions.

Prior to selecting a new system, it is also necessary to evaluate the system component manufacturer and system maintenance requirements. The insights gained can significantly enhance decision-making.

Factors to Consider When Converting Fire Suppression Systems

When exploring alternatives to AFFF, several considerations are at play, beginning with the environmental impact of a system conversion. It's important to assess how much of an existing AFFF system can be reused in a conversion and the level of environmental risk owners take on when reusing components that once contained AFFF.

When evaluating the risks of reusing components that previously contained AFFF, it's critical to consider how future discharges, still potentially high in PFAS concentrations, could impact the environment. Key considerations include the likelihood of a discharge reaching surface water bodies or other sensitive receptors. In some cases, soil, groundwater and surface water investigations may be necessary to fully assess environmental risks.

The cost of alternative systems also matters when considering a conversion. The most cost-effective approach often involves selecting fluorine-free foams (F3) with similar application densities to AFFF and those that are approved for use with existing discharge components.

Alternatives to AFFF

Depending on the facility protected, those who rely on AFFF currently have multiple alternatives to consider, including water-only, high-expansion foams, fluorine-free low-expansion foams, clean agents and underfloor drainage systems. Determining the most suitable applications for each option can be complex, necessitating thorough risk and hazard evaluations and the guidance of fire protection professionals.

For example, water is an inexpensive and widely available fire suppressant, but it isn't as effective in flammable liquid fires as foam. It can take increased time to control and may not fully suppress a fire. However, when water-only systems are combined with other systems, such as underfloor drainage, the effectiveness increases. The water controls the spread of the flammable liquid fire while the fuel is simultaneously removed from the area of the incident.

High-expansion foam, on the other hand, is known for its ability to rapidly fill large spaces and remove oxygen from the fire, making it highly effective on three-dimensional fires in hangars. More effective than water-only in combating aviation fuel fires with similar effectiveness to AFFF. However, High-expansion foam does have some limitations that should be considered.

Fluorine-free low-expansion foams are designed to meet the same testing standards previously used for AFFF while minimizing the associated environmental and health risks of PFAS. Many consider these foams a viable alternative to AFFF. While these foams are continually improving and their technical envelope expanding, the application densities and pressure required at the discharge devices can exceed AFFF's previous performance criteria, requiring additional system modifications when transitioning from AFFF to an F3 alternative.

Given the complexity of fire scenarios and the varying effectiveness of each alternative, it is crucial to leverage the experience of fire protection professionals when developing a comprehensive fire suppression strategy that addresses risks while minimizing environmental and health impacts.

Fire Suppression System Conversion Process

A fire suppression system conversion is completed in multiple phases (see Figure 1).

Managing Possible PFAS Contamination

In some cases, the system conversion process may take place alongside testing, monitoring or remediation of PFAS in the surrounding soil and groundwater.

Several federal and state rules are in place or pending that could potentially impact these activities. The U.S. Environmental Protection Agency (EPA) has finalized maximum contaminant levels (MCLs) for certain PFAS compounds in drinking water. Several states have adopted these MCLs as groundwater cleanup standards. This may obligate some airports to monitor and, if necessary, treat water and groundwater containing excess levels of certain PFAS.

The EPA has designated PFOA and PFOS as hazardous substances under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The EPA has also proposed listing several PFAS compounds as hazardous constituents under

Phase	Activities
Initial Assessment	• Evaluate existing system, assess the fire hazard and requirements for the new system in consultation with fire protection engineers and regulators.
Design	• Choose appropriate fire suppression technologies. • Upgrade existing system to be code-compliant as part of the AFFF-to-F3 conversion or seek engineering equivalencies from the fire marshal. • Form plans for integrating the new system with existing infrastructure. • Develop detailed engineering drawings and specifications.
Permitting and Approvals	• Obtain necessary permits and approvals.
Procurement and Scheduling	• Procure fire suppression system components and temporary fire protection and effluent containment equipment. • Coordinate with airport operations, maintenance crews, contractors and regulators on detailed schedule development.
Installation and Startup	• Implement fire watch and temporary protection measures before taking the existing system offline. • Remove old components and install new ones. • Integrate the new system with existing infrastructure. • Test to confirm functionality and fire code compliance. • Train personnel on operations and maintenance.

Figure 1: ***Phases of a fire suppression system conversion.***

the Resource Conservation and Recovery Act (RCRA). Both cleanup-focused regulations could affect the management of PFAS in soil, groundwater and surface water of facilities that previously used AFFF.

Amid evolving federal rules, many states have established and continue to develop their own PFAS regulations, including more stringent MCLs for drinking water, soil cleanup standards and groundwater remediation requirements.

Testing for PFAS

If an airline, airport or other entity determines that testing environmental media — such as soil, sediment, groundwater or surface water — for PFAS is necessary, experienced environmental professionals can guide them through the process. An environmental site investigation, tailored to the site, involves multiple steps, starting with a site visit to identify potential sources of PFAS contamination and areas where AFFF might have been released.

Then environmental engineers, scientists and geologists typically develop a conceptual site model to assess potential PFAS migration pathways and identify receptors at risk of exposure. If PFAS is suspected in the soil, samples may be collected from places where AFFF was stored or used.

To test groundwater, monitoring wells can be installed at locations and depths that intersect potential PFAS-contaminated zones. By analyzing the concentration and distribution of PFAS in soil and groundwater, professionals can assess potential risks. Based on this evaluation, they can develop a remediation plan aimed at reducing PFAS concentrations to acceptable levels, as defined by the regulatory agency overseeing the site.

The Remediation Process

Depending on the specific circumstances at each site, a remediation plan may involve soil excavation, groundwater treatment or hydraulic containment measures. Additionally, it may include a long-term monitoring program to track the effectiveness of remediation efforts and see that PFAS levels remain below regulatory thresholds (see Figure 2).

Mitigating Risks and Minimizing Disruption During Conversions and Remediation

An airport's fire suppression strategy during construction may include plans for reducing the risk of fire, increasing the awareness of a fire event or providing a temporary suppression alternative. These plans, along with any potential remediation plans, would also seek to minimize the impact on airport operations.

Soil Remediation Techniques	Groundwater Remediation Techniques
Excavation and Disposal: Contaminated soil is excavated using heavy machinery and transported to a landfill or hazardous waste facility that can safely handle PFAS-contaminated materials.	**Pump and Treat:** Contaminated groundwater is pumped to a treatment system at the surface, where it is treated using granular activated carbon, ion exchange resins, high-pressure membranes (e.g., reverse osmosis) or foam fractionation to remove PFAS.
Soil Washing: Soil particles are separated and washed with a solution that removes PFAS. The PFAS-containing wash water is then typically treated using one of the EPA's best available technologies (BAT): activated carbon adsorption, ion exchange or reverse osmosis.	**In-Situ Treatment:** Permeable reactive barriers containing materials that adsorb PFAS (such as colloidal activated carbon) are installed in the path of groundwater flow.
Stabilization and Solidification: Chemical agents are mixed with contaminated soil to immobilize PFAS, reducing its bioavailability and ability to migrate.	**Monitored Natural Attenuation:** Natural processes such as dilution, dispersion and adsorption are used to reduce PFAS concentrations over time.
Thermal Treatment: PFAS in soil is destroyed through incineration or removed via thermal desorption.	

*Figure 2: **An overview of soil and groundwater remediation techniques.***

Fire suppression system conversion risks can be mitigated in multiple ways. For example, activities such as welding and the use of flammable liquids may not be permitted to reduce the risk of initiating a fire. This may be coupled with a fire watch to increase the awareness of a potential fire event. Temporary foam systems may still be required by the fire marshal where some higher-risk activities are still required by airport operations. Additionally, it may be possible to phase construction in such a manner to reduce fire suppression outages to only a few hours.

Construction and, if needed, PFAS remediation activities can be scheduled for off-peak hours to minimize disruptions. Rapid excavation techniques can be employed to speed the removal of contaminated soil. By choosing permeable reactive barriers or in-situ stabilization, it may be possible to treat contaminated groundwater with minimal excavation. Monitoring wells can be installed in places where they can be used to assess the effectiveness of groundwater remediation without impacting active flight line safety.

Signage and blockades can help delineate work zones from active flight areas to minimize disruption to airport operations. Above all, regular communication with airport management, traffic control and ground operations teams is critical to support safety and minimize the impact of conversion and remediation activities.

The Bottom Line

AFFF is a well-known source of PFAS, prompting airlines and airports to seek economical fire suppression alternatives for hangars and other aviation facilities. Many are proactively addressing this issue to stay ahead of regulations and to support the overarching mission of PFAS reduction.

Adopting a comprehensive approach that includes converting to a non-PFAS fire suppression solution and mitigating PFAS contamination offers multiple advantages. It not only facilitates compliance with current and upcoming regulatory standards but also demonstrates a commitment to environmental responsibility and operational excellence. By taking these proactive steps, airlines and airports can contribute to a safer, cleaner environment for all.

About Burns & McDonnell

Burns & McDonnell is a family of companies bringing together an unmatched team of engineers, construction and craft professionals, architects, and more to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities. Founded in 1898 and working from dozens of offices globally, Burns & McDonnell is 100% employee-owned. For more information, visit **burnsmcd.com**.

8263096303-0425