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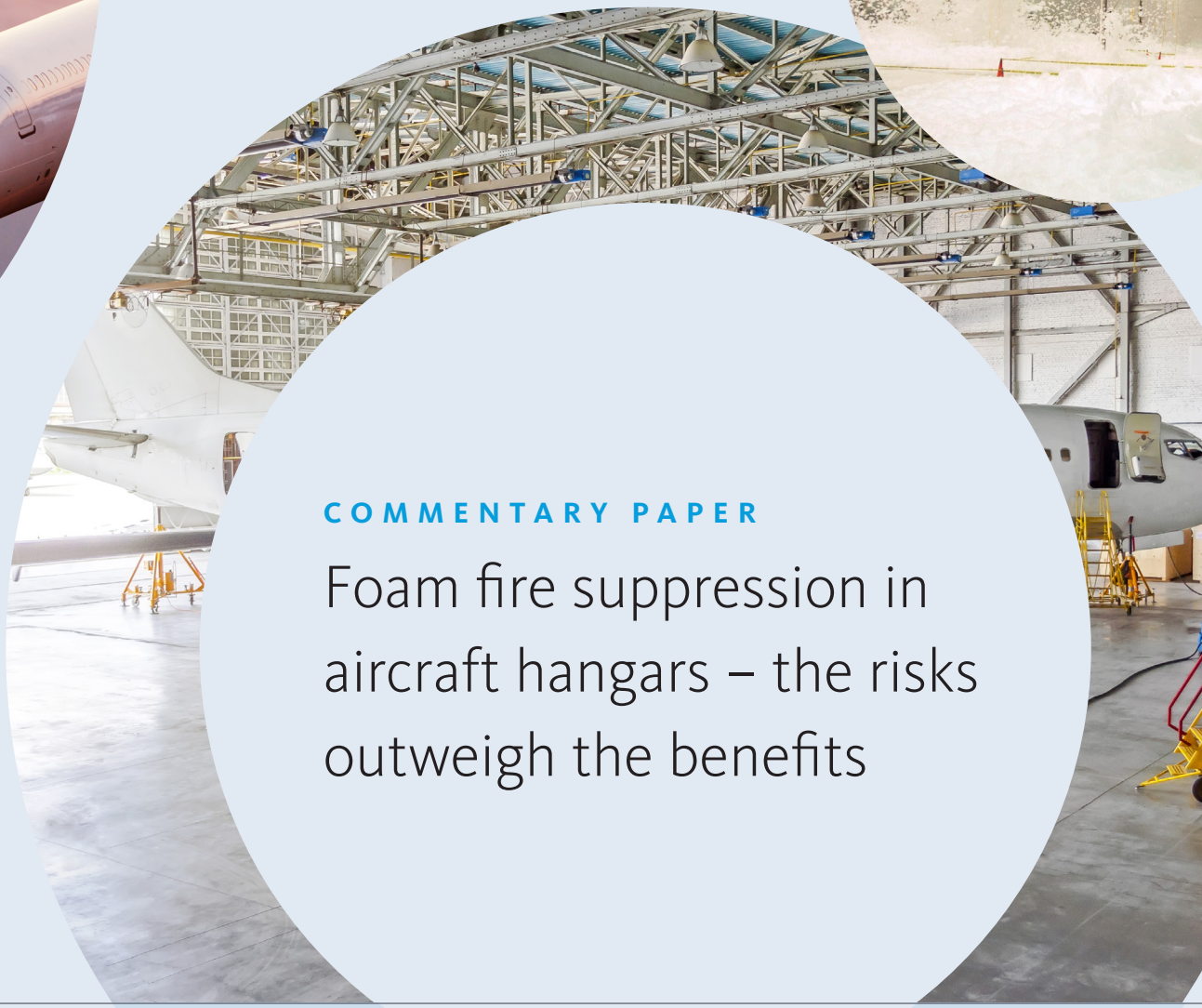

COMMENTARY PAPER

## Foam fire suppression in aircraft hangars – the risks outweigh the benefits

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COMMENTARY PAPER

# Foam fire suppression in aircraft hangars – the risks outweigh the benefits

## Expected growth of the aviation industry

To say that the past two years have been challenging for the aviation industry is an understatement. Passenger traffic plummeted by two-thirds in 2020 compared to 2019 and recovery has been slower than expected. In fact, the International Air Transport Association (IATA) forecasts that 2022 traffic will be just 60% of pre-pandemic levels.

As it relates to growth, France's Airbus – through its global market forecast – and the United States based Boeing – through its commercial market outlook, publish annual traffic projections. Airbus's most recent forecast covers the 2021-2040 period and reports that passenger traffic could return to 2019 levels between 2023 and 2025. Airbus's forecast also projects that global traffic will grow an average of 3.9% per year between 2019 and 2040. Boeing's outlook offers a similar growth projection of 4.0% per annum over the same 22-year period. Additionally, as of March 31, 2022, Boeing has a backlog of 4,176 planes. As of May 2022, Airbus has orders for 21,072 planes. Based on these projections, maintenance in aircraft hangars will likely dramatically increase alongside the number of hangers around the world.

The figures above reflect projects and orders for the world's two largest plane manufacturers. Countless additional manufacturers, such as Canada's Bombardier and Brazil's Embraer, not to mention private jet fabricators, will likely benefit from future growth.

## How foam fire suppression systems work

Foam suppression is a type of wet chemical system that combines both water and a foaming agent for large scale fire extinguishment. Foam suppression systems extinguish fires by cooling, altering the chemical reaction that occurs during combustion and separating fuel from oxygen. To do this, the extinguishing agent fills the protected space with foam suppressant, blanketing a potential fuel spill as well as covering additional fuels. High expansion foams work by filling the volume of a building from floor upwards – suffocating and cooling the fire and fuels.

Hangar foam fire suppression system

Foam suppression systems are also designed a lot like a deluge wet sprinkler system in that stored water flows through an extensive network of pipes, where it is then discharged through multiple foam generators (which look like large fans, mixing a foam concentrate and water for discharge). The foaming agent concentrate is stored in a tank separate from the water, and the two become mixed within the system before being discharged from the generator. Aside from aircraft hangars, foam systems are also commonly utilized in jet engine test sites, marine applications, as well as flammable liquid storage and distribution facilities.

## Loss considerations

Nick Methven, senior vice president and underwriting executive at Global Aerospace, published a whitepaper where he conveyed the following: *"Aircraft hangars are unique structures with configurations and contents that can pose unusual hazards. Often very large with high ceilings, they typically house aircraft that are asymmetrical objects containing flammable or combustible fuel. Aircraft support apparatus such as tugs, maintenance equipment and vehicles contain possible fire ignition sources. All of this can be disconcerting and surely the concern around potential fires is understood.*

Inadvertent discharge of a foam fire suppression system

*But where are the fires? Personnel at Global Aerospace have spoken to clients and many others in the aviation industry and not one person can recall a single event where a fuel spill ignited and activated the hangar foam fire suppression system.*

*The claims data developed by Global Aerospace suggests that false activations dominate the activity in this area. Inadvertent foam discharges damage property, interrupt businesses and takes aircrafts out of service. To be fair, industry data gathered during the past 20 years suggests that hangar fires, while quite rare, are not unheard of. However, the origin of these fires is not usually the aircraft fuel and the fires tend to occur in less sophisticated hangar environments."*

Mr. Methven goes on to say that *"At Global Aerospace, we decided to look at our own claims data over the past 12 years, to test the hypothesis that fire suppression systems were triggered by false activations instead of actual fuel spill fires. Our study was conducted in December 2018. Global Aerospace discovered 51 claims around the world where the claims description involved "uncommanded activation," "unintentional dispersion of foam", "erroneous operation of fire suppression system" and "inadvertent discharge." Global Aerospace found no examples of an intentional discharge in response to a fire. The mean value of the resulting claims exceeded $1 million."*

As noted, there are costly ramifications associated with an inadvertent discharge of a foam fire suppression system. Below are a few loss considerations:

- Aircraft damage – While the water-based foam can prevent the aircraft from being destroyed by fire, it can also damage sensitive systems in the process – requiring expensive repairs or replacement of components. From an aviation claims perspective, the most common aircraft damages in the aftermath of a foam discharge event relate to brake assemblies, avionics, electronics and engines. When all of these components are affected, repairs can easily exceed $1 million. Original equipment manufacturer (OEM) protocols, pertaining to repair scopes for aircraft subjected to a foam event, vary significantly. From a rinse down to a tear down, required repairs cover the spectrum and the costs can be substantial.

F16 fighter jet foam inside the engine and cockpit

- Hangar equipment damage – Other assets in the hangar including vehicles, tools and support equipment may be impacted.
- Loss of business – From missed flights and costs associated with arranging a substitute aircraft, to loss of business in the hanger itself – an accidental discharge can negatively impact operations.

Black Hawk helicopter foam exposure

There are several reasons why inadvertent foam discharges happen:

- Similar to most electrical or mechanical assemblies, manufacturing design deficiencies that go undetected will surface following a system malfunction.
- OEMs do not often install their own systems; there is heavy reliance on third party installers. At times, lack of training uniformity among smaller installers results in improper installation and commissioning.
- Inadequate system maintenance also plays a role.

Kerry Porter, director of claims for the United States Aircraft Insurance Group (USAIG) stated that, *"Our experts indicate that the cause of inadvertent foam dumps is often poor or totally lacking maintenance of the fire suppression systems by the fixed base operators (FBOs)."*

Fixed base operator hangar

In some cases, there are changes made to the system's operational sequence, but those changes are not documented. When it's time to test the system during an annual inspection, the result is a hangar full of foam. Some systems have reacted to false positives, such as smoke and heat from welding work or an in-hangar barbeque. Non-emergency depression of the foam activation button – a manual release – has also accidentally happened.

According to a study commissioned by the National Air Transportation Association (NATA) from the University of Maryland's Department of Fire Protection Engineering, since 2004 there have been at least 137 inadvertent hangar foam discharges – an average of one every six weeks.

Mr. Petersen of Willis Towers Watson stated that, "*The high costs to install, the risks to people and property from inadvertent discharges, and the hundreds of millions of dollars lost because of them, are massively disproportionate to the utility of these systems, as there is no data showing a foam system has ever been deployed in response to an actual fire and people or property were saved from harm."*

At this point, we recognize that hangar foam suppression systems are effective if a fire actually occurs, although the risk of inadvertent discharges can be costly. With all that said, aircraft are designed to withstand harsh environmental conditions. What is it about the foam that leads to damage?

"Foam is corrosive, so if it infiltrates the avionics bay, some manufacturers of the black boxes will require replacement because of the likelihood of future failures. They believe operational failures could possibly follow as corrosion progresses," said Kerry Porter at USAIG.

Porter explains that due to the corrosive nature of the foam, what would appear to have a minimal effect on an aircraft, could require costly replacements. "Depending on the aircraft brand, a large corporate jet that gets only two feet of foam around it, instantly costs over $1 million in mandatory replacement of wheels and brakes." "If it gets foamed again a month later, which has happened, that is another million in replacement wheels and brakes."

Chemguard C2 is a firefighting foam concentrate. The composition of the concentrate includes 25-35% water, 3-6% diethylene glycol monobutyl ether and 12-17% ethylene glycol (which is corrosive). Most corrosion from ethylene glycol results from decomposition of organic acids. Aluminum alloy corrosion in the presence of ethylene glycol, is presumed to be the result of an acidic attack by these acids. The quality of water as a conductive ingredient within the foam is unknown. While aircraft engines are designed to withstand water exposure, sensitive electronic assemblies within the aircraft are susceptible to damage if not mitigated.


Fighter jets foam exposure

## Environmental risks

According to the Air Force Civil Engineering Center (CEC), "Per- and Polyfluoroalkyl Substances, or PFAS, are a group of man-made chemicals used for a wide variety of residential, commercial and industrial purposes including nonstick cookware, stain-resistant fabric and carpet, some food packaging and firefighting foam." The U.S. Food & Drug Administration notes that, "PFAS do not easily breakdown (break down) and some types have been shown to accumulate in the environment and in our bodies. Exposure to certain types PFAS have been linked to serious health effects."

While there are over 4,700 types of PFAS, for the purposes of this commentary we will focus on two, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). The Air Force CEC goes on to state that "PFOS and PFOA are components of legacy Aqueous Film Forming Foam (AFFF) the Air Force began using in the 1970s as a firefighting agent to extinguish petroleum fires; AFFF provides essential burn-back resistance, protection against vapor release and rapid extinguishment.

In November 2015, more environmentally responsible AFFF formulas were added to the Department of Defense's qualified products list for firefighting agents. The Air Force began replacing both PFOS-based and other legacy AFFF products with a new, environmentally responsible formulas." While the Air Force has moved in the right direction to protect both personnel and the environment, the private sector has not upgraded as quickly systems that contain PFOSs and PFOAS.

## Industry standard

The National Fire Protection Association (NFPA) addresses aircraft hangars under its 409 standard. The standard was last updated in 2016. While NFPA has no rulemaking authority on its own, its guidance is generally accepted as an industry standard and referenced by state and local governments when approving hangar construction. The 409 standard was established more than seven decades ago. At the time, hangars cost more than the aircraft they sheltered. These days, hangars can house several business jets, one of which alone could be worth more than 10 times the price of the building.

Lance Toland, founder of Lance Toland Aviation Insurance Managers, concludes the following, "Many industry observers lament that NFPA 409 has not kept pace with the modernization of aviation. For example, aircraft construction and manufacturing techniques have improved to the point where aircraft fuel leaks are a rare event. You could throw a match in today's Jet A fuel and it won't ignite – referring to advancements in fuel technologies that have raised the flashpoint of this type of fuel. Many experts believe that fire suppression system activation should be a manual process in sophisticated environments, which would allow for human confirmation of a fire instead of relying on sensors that might prove to be faulty or erroneous."

## Expert analysis

Following a claim or as part of subsequent litigation, utilizing a qualified forensic expert is integral to the investigation, whether the incident involves a fire or inadvertent discharge of a suppression system. Fire suppression systems should be investigated by licensed fire protection engineers experienced in failure analysis.

## About EFI Global

EFI Global, part of Sedgwick, is a well-established brand with an excellent reputation in the Americas, Africa, Asia-Pacific and Europe as a market leader in environmental consulting, engineering failure analysis and origin-and-cause investigations. Each year, EFI Global completes more than 45,000 projects worldwide for a wide range of clients, such as commercial, industrial, institutional, insurance, government, risk managers, public and private entities. EFI Global is one of the world's most respected emergency response firms, capable of providing practical solutions to the most complex problems. Our multidisciplinary team of first responders, project managers, engineers, geologists and scientists are selected for their technical proficiency and in-depth industry knowledge to aid clients in resolving technical problems. For more, see **efiglobal.com**.

## Get in touch with an expert

**Jay Kramarczyk, MS, PE**
EFI Global's forensic fire protection engineering team is led by Jay Kramarczyk, MS, PE. Jay is a licensed engineer in numerous states nationwide and is a practicing expert witness in fire protection and mechanical failures, as well as fire and explosion investigations. For questions about this article or for assistance with potential projects, contact **Jay.Kramarczyk@EFIGlobal.com**.

**Diane Spinner**
With more than 21 years of experience in fire service and investigations, as well as law enforcement, Diane Spinner serves as senior fire investigator. Diane is a member of the Palm Beach County Arson/Bomb unit, where she investigated fires and was responsible for the juvenile fire setters' program. Prior to being assigned to the Arson/Bomb squad, Diane was a deputy sheriff. Diane has more than 500 hours of training specific to fire origin and cause investigation including classes from the National Fire Academy, Criminal Justice Training Institute and Michigan State Police. She is a certified fire investigator through the International Association of Arson Investigators, a certified marine investigator through the International Association of Marine Investigators and a certified fire and explosion investigator. Diane possesses Pro Board Recognition and has conducted more than 4,000 investigations in her career, including qualifying as an expert witness in arson related judicial proceedings. For additional information, contact **Diane.Spinner@EFIGlobal.com**.

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