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WHITE PAPER

THE RISK ASSESSMENT LOOPHOLE UNDERMINING AIRCRAFT HANGAR SAFETY

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Introduction

Aircraft hangars are some of the most expensive and operationally critical assets in aviation. In recent years, a quiet and limited shift has taken place—affecting only a small number of hangars, yet ones that are critical to the industry. This shift concerns how fire protection requirements are interpreted and applied, particularly in maintenance facilities. A well-intended exception in NFPA 409 has become a loophole and is being misused by some.

How a Risk-Based Exception Opened the Door to Misuse

In 2022, NFPA 409 introduced a risk-based alternative that allows hangar owners to forego foam fire suppression if a qualified fire protection engineer performs a site-specific risk assessment showing a sufficiently low hazard. This provision was added with practical intent—particularly for fixed-base operators (FBOs), where hangars are used primarily for overnight parking or light handling. These facilities have a lower risk profile compared to full-service maintenance hangars, and in some cases, may not warrant the complexity and cost of a full suppression system.

That's not the issue.

The issue is when that same clause is used to justify minimal protection in Group I and Group II maintenance hangars—environments where ignitable liquids are still present and fire hazards are real. In the 2022 edition, there is already an allowance for reduced fire protection in Group II aircraft hangars that do not perform hazardous operations, so the use of a risk-assessment in hangars is clearly conducted when "hazardous operations" are being performed in these hangars.

These facilities regularly involve work on fuel system components, part replacements, and routine maintenance procedures that can involve residual fuel. Yet some assessments downplay these realities to avoid fire protection requirements altogether. The justification is typically rooted in the rigor of maintenance procedures regulated and developed by the aircraft manufacturer and the extensive training and certification of aircraft maintenance technicians. Unfortunately, training and procedures can never fully eliminate the inherent risk of handling ignitable liquids in maintenance operations. This assumption overlooks the unpredictable nature of fire hazards and demonstrates a troubling complacency that favors the theoretical safety of maintenance procedures over established, effective fire protection strategies.

What Happens When Jet Fuel Ignites in Hangars

Jet fuel fires are not theoretical. Wide-body aircraft like the Boeing 777 can carry up to approximately 48,000 gallons of fuel. A fire may start small—originating from an electrical fault, a maintenance spark, or equipment failure—but with that volume of fuel present, it can escalate rapidly. As the fire grows, increasing amounts of the aircraft's fuel begin to participate. The energy released quickly surpasses the capabilities of conventional sprinkler systems to control or contain it.

Figure 1: 120 Gallon Jet-A Fire Test conducted at Safespill's Fire Training Facility near Houston, TX

This is backed by both industry data and direct experience. Safespill recently conducted a controlled, small-scale test at its facility, igniting 120 gallons of Jet A (Video) fuel protected by a water-only, deluge sprinkler system with a density of 0.2 gal/min/ft^2 mounted at just 20 feet. Even under these favorable conditions, the sprinklers failed to control the fire. Instead, they contributed to the production of heavy, toxic smoke. In a real-world setting, that smoke would destroy aircraft electronics, control panels, electrical systems, and lighting—while contaminating many other surfaces. At best, the hangar would be shut down for weeks of cleanup, inspection, and remediation.

This risk is further amplified by the materials modern aircraft are made of. Today's commercial and military aircraft increasingly use composite materials for fuselages and wings—materials that can delaminate, auto-ignite, and support flame spread as documented by the Federal Aviation Administration[1] (FAA) and United States Air Force Research Laboratory[2,3] (AFRL).

In a separate study conducted by Safespill[4], an analysis of an F-35 hangar fire demonstrates how aircraft composed of composite materials can ignite when subjected to sustained heat fluxes, becoming part of the fuel load themselves. While that study was military-focused, the fire dynamics apply equally to commercial composite aircraft like the 787 and A350.

Factory Mutual— typically considered to be the gold standard in industrial fire protection—has reached the same conclusion. In FM Property Loss Prevention Data Sheet 7-93[5], guidance for aircraft hangar fire protection does not permit risk-based assessments as a justification for reducing fire protection requirements. They recognize that the only acceptable methods for mitigating ignitable liquid fires in hangars are the same approaches prescribed by NFPA 409: AFFF foam, high-expansion foam, or ILDFA. Any deviation from these options is considered inadequate protection.

The Problem with Predetermined Outcomes and Hidden Fire Data

The risk assessments in question are often performed with a predetermined outcome in mind. In many cases, it starts with a fire protection engineering firm introducing the idea to the owner—proposing that the requirements of NFPA 409 may be reduced or avoided entirely through a risk-based assessment. This shifts the owner's mindset from compliance to cost-cutting. What was once understood as a prescriptive fire protection requirement becomes a financial decision, guided by consultants whose business model is to deliver reports that enable deferral of fire protection measures.

This model has become a revenue stream for a small but visible subset of engineering firms. Rather than objectively evaluating risk, their assessments are crafted to support an outcome that was effectively pre-selected: to avoid fire protection. This isn't a matter of professional disagreement or judgment—it's willful blindness, enabled by entities entrusted to uphold safety standards.

We've encountered reports suggesting that hangar fires are virtually nonexistent. But the historical record shows otherwise. Safespill's research[6] has identified over 90 documented destructive hangar fires in the past 40 years—many of them occurring in Group III hangars that were classified as "low risk" and therefore lacked meaningful fire protection.

Group I and II hangars have also experienced fires, though these incidents are often kept out of the public domain—especially when large organizations are involved. Confidentiality agreements, internal reporting structures, and public relations considerations frequently prevent these events from being disclosed. In many of these cases, however, prescribed fire protection systems were already in place—presumably preventing the fires from escalating and helping ensure they were contained before becoming catastrophic.

The same is true—if not more so—for the military. Military bases have no obligation to report internal incidents to the public. Yet many of the same maintenance procedures and operational risks present in commercial hangars also apply to military aircraft hangars. One of the few publicly known examples is the B-1 bomber fire at Dyess Air Force Base[7], which came to light because someone recorded it from outside the base perimeter.

Figure 2: Snapshots from video of B-1 fire at Dyess Air Force Base

Legacy Foam Systems and the Rise of ILDFA

Legacy foam systems, particularly those containing PFAS-based agents, created significant long-term consequences. Accidental discharges corroded avionics and aircraft engines, causing major damage to the aircraft. They also released persistent "forever chemicals" into the environment—substances that bypass water treatment systems and entered the drinking water supply and food chain. PFAS exposure has been linked to various cancers, birth defects, and serious chronic disorders. Faced with growing legal, environmental, and health concerns, the industry rightly sought alternatives. But eliminating fire protection altogether was never the intent.

Recognizing this, the 2022 edition of NFPA 409 included Safespill's Ignitable Liquid Drainage Flooring Assembly (ILDFA) as an approved solution. ILDFA removes the fuel itself—draining it before ignition. No foam. No environmental risk. No delayed suppression. It provides true protection without the liabilities of older systems.

Conclusion: Honest Risk, Real Solutions

This is not an attack on risk-based flexibility. Risk assessments have their place—particularly for FBOs and other low-risk facilities. And this isn't about pressuring Authorities Having Jurisdiction (AHJs), who must make difficult decisions with limited data.

The issue is the misuse of these assessments in high-risk hangars. When tens of thousands of gallons of fuel are present, and adequate fire protection is deliberately excluded from the design, that's not risk-informed decision-making—it's a dangerous erosion of safety standards.

ILDFA offers a better answer. It directly addresses the source of the hazard—fuel on the floor—and removes it before ignition.

For decades, the aviation industry has prioritized protecting aircraft and hangars from fire, even when the environmental and operational burdens of foam systems were high. The understanding was always clear: the risk of fire in and around these aircraft is unacceptable. A small number of bad practices should not be allowed to compromise what has historically been a safety-first industry. That's why this must stop.

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