NFSA NATIONAL FIRE SPRINKLER ASSOCIATION
The Voice of the Fire Sprinkler Industry

TechNotes

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Hangar Hassles

Aircraft hangars present a series of intense and unique fire hazards. To combat these potentially devastating fires, NFPA 409, Standard on Aircraft Hangars, prescribes an approach that can include multiple fire suppression systems working in conjunction in the same space. This edition of TechNotes will attempt to explain some of the justification behind these requirements as well as some potential considerations for designers. Due to some of the adverse effects listed in the first section below, foam systems are becoming less favorable, dramatically increasing the importance of hangar sprinkler systems.

Adverse Effects of Foam Systems

In a recent study, in the seventeen years from 2004 to 2020, foam systems have discharged numerous times, but these activations have rarely been in response to a real fire. The cleanup resulting from these incidents can be quite costly for hangar owners and for the owners of the aircraft. As aircraft have become more advanced, their fuel tanks are less susceptible to leaks, meaning that the fuel fires that foam systems are installed to combat are becoming less common.

Another better-known drawback of foam systems is the media used to extinguish the fire, the foam concentrate. One of the main low expansion foam agents currently in use is Aqueous Film Forming Foam, also known as AFFF. These systems have also severe health impacts due to the per- and polyfluorolkyl substances, in this case perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). These chemicals can cause several afflictions, such as cancer and liver diseases. These substances also remain in the bloodstream for numerous years. In response to these findings, foam concentrates containing these substances are being banned in numerous states. In some states, these foam concentrates are being destroyed to prevent them from being used. In addition to the lack of sales of AFFF concentrate, these efforts are dramatically reducing the stock and use of AFFF.

System Components

The most prevalent fire suppression systems in aircraft hangars are Class B foam systems. These systems might be high expansion, low expansion, or even foam deluge systems. While not designed for it, these systems might be successful at extinguishing Class A fires, but they are prescribed to combat fires resulting from fuel spills.

In addition to these foam systems, sprinklers can usually be found in hangars. These systems can include sprinklers in accordance with NFPA 13 Standard for the Installation of Sprinkler Systems and foam water systems per NFPA 16, Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems. These systems are installed both due to their superiority at extinguishing Class A fires, as well as to protect the structure. It undoubtedly would take a significant fire to quickly activate the sprinklers at the height typical for many aircraft hangers. Yet, these sprinklers are designed to activate in the case of elevated ceiling temperatures that may damage the steel structure of Group I and II hangars.

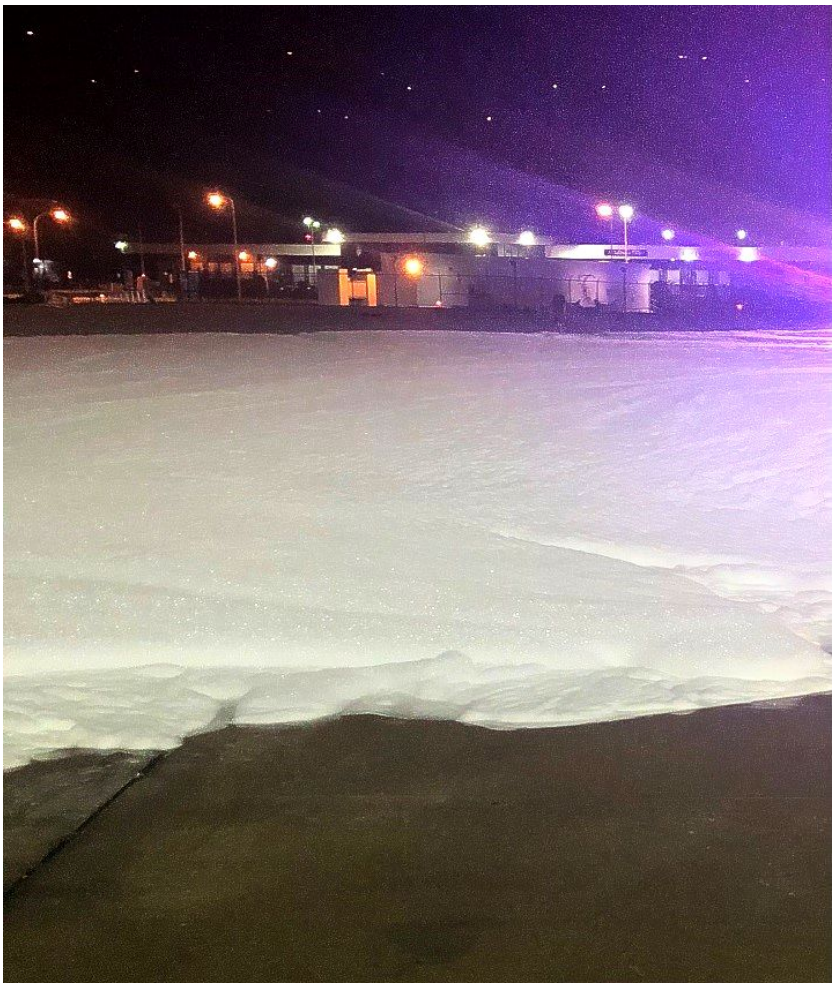
These sprinkler systems must be wet or pre-action systems to limit the delay in water delivery time inherent in dry sprinkler systems. The annex material also goes on to state that pre-action systems should only be used for environments that cannot be maintained at a temperature above 40°F. It also states that only single interlock pre-action systems should be used to further minimize the sprinkler response time.

Fire Plumes

As previously mentioned, fuel spills are not as common in today's hangars as they once were. However, because fires resulting from these incidents are the justification to install foam systems, the impacts of fuel fires should be analyzed. For example, a common type of jet fuel, JP-8, had a measured heat of combustion of .991 MJ/kg, equating to a total energy load of 2.64 MJ for a pool with a 1-meter diameter. This released heat warms the surrounding air, which rises toward the ceiling. As this air is displaced, cooler air is entrained at the base of the fire which will then begin its own journey upward. A fire of such magnitude will create a formidable plume for water to penetrate. Clearly, extinguishing a fire of this magnitude quickly is of utmost importance, especially when very expensive

aircraft are threatened.

While not currently approved in the prescriptive NFPA standard, performance-based designs employing sprinkler systems as central fire suppression systems are becoming far more common. While these systems may suffer from far fewer unwanted activations than foam systems, designing them can certainly be a challenge.



Aftermath of an unwanted foam system discharge. Photo by Author

While foam agents like Aqueous Film Forming Foam (AFFF) seal on top of the surface of the fuel, preventing the ignitable vapors from escaping, water mainly extinguishes a fire by removing the heat from the fire. To accomplish this task, water must be able to reach the seat of the fire. However, in the case of these potential fuel spill fires, water must be able to travel through the plume to the seat of the fire before the droplet can evaporate, meaning that it needs sufficient momentum to penetrate the fire plume. Yet as previously discussed, a fire with such a high heat release rate and in such a tall space produces a plume that can be quite difficult for water to penetrate. Therefore, sprinkler discharge can evaporate before even approaching the seat of the fire.

Hardware Choices

The momentum equation states that momentum is equal to the mass of the object times its velocity. Because the velocity of the water is dictated by the acceleration due to gravity, the mass of the droplet must be increased. Thus, a larger K factor is needed. The standard states that the heads must be either K=5.6 or K=8. While this may ensure that the droplet will reach the seat of the fire, it could also mean that the droplet may not be completely evaporated, and therefore it may enlarge the fuel spill. Thus, foam systems are currently prescribed for hangar applications.

Conclusion

While sprinklers only constitute part of the solution to hangar fires, they play a vital role and absolutely have a place in hangar fire protection.

Please note that this TechNotes was written for informational and guidance purposes only and that any applicable NFPA standards as well as local requirements should be followed to ensure that the fire protection systems are being properly maintained. As always contact your local fire protection contractor for assistance with your fire protection systems.

References

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Top Tech Competition

The National Fire Sprinkler Association is looking for the best Fire Sprinkler Design Technicians in the land! If you know

NFPA 13 inside and out, can figure out optimal spacing for rooms of unusual dimensions in your head, or have memorized what size suction pipe needs to be used with each size of fire pump...then you might have the right stuff for the Top Tech competition!

The Top Tech Online Exam opens April 1, 2021! Check out on the details at: **https://nfsa.org/toptech/**

New EOD Process

Starting on July 15, 2020, the NFSA has a new EOD process where members can submit questions, track the progress, and view their EOD cases. The step by step process is detailed in **TechNotes #442**.

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