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HANGAR DEFUELING? WHAT IS SAFE?

Research Request:

For operators who are located away from a full service airfield and can choose the fueling location for their aircraft, what are the benefits, requirements, and safety considerations for defueling aircraft inside the hangar? Detail the risk and rewards associated with hangar defueling. This topic can be viewed as filled with all kinds of opinion and personal thoughts paired with decades of "That's how we've always done it" or "why take the risk" arguments. PRISM will try to provide a clear picture for the operator to make a decision that fits their needs and risk tolerance.

Disclaimer:

This research brief should be used as informational purposes to help your organizations analyze and develop counter measures to prevent accidents, incidents, and fire danger. This report will provide suggestions and best practice techniques which should be properly evaluated by your management prior to use or implementation.

Background:

When it comes to the maintenance of aircraft, fuel often has to be removed prior to any work being started on the aircraft. Defueling has many of the same issues that fueling/refueling present to maintenance personnel and air crews. Because most maintenance takes place in hangar, it makes sense that pre-maintenance defueling would also occur in the hangar. However, dealing with fuel and other hazardous materials poses different hazards while indoors versus outdoors in a designated area. State and local regulations will dictate what an operator can and cannot do regarding fuel and fire safety. Operators should analyze their own risk tolerance in the absence of regulation.

Initial thoughts and considerations behind each location can include:

- Maintenance accessibility
- Fire safety and prevention, safety regulations
- Hazardous material considerations
- Interference with other aircraft, personnel
- Weather disruptions

On the following pages you will find information that addresses the above considerations, examples of incidents regarding fuel safety, and a conclusion to this research brief, as well as resources for finding more information and regulations. Many of the recommendations are similar to general fueling guidelines.

Hazards of Fueling

Flash point

All aviation fuel is combustible and has the potential to ignite. A fuel's flash point is the lowest temperature at which **vapors** of the fuel will ignite. There must be a source of ignition such as a spark for fuel vapors to ignite at its flash point. AvGas is the most combustible of the major aviation fuels.

Jet A: 38 °C (100 °F)

Jet B: −18 °C (-0.4 °F)

AvGas: −43 °C (−45 °F)

This should not be confused with the fuel's auto ignition limits. The auto ignition limit of a fuel is where it's vapors will combust spontaneously due to external conditions (temperature and pressure), and is significantly higher than the flash point.

Vapors

All fluids have vapors. The amount of vaporization depends on the fluid, the temperature, and air pressure. They can build quickly and without notice. Because the vapors are heavier than the surrounding air and will not necessarily be near faces, personnel *should not* rely on smell to determine if vapors are accumulating.

Static Buildup

As fuel is pumped it creates friction with the hoses it is pumped through, which can lead to a buildup of static electricity. As the buildup increases, the differential of electrical charges between the aircraft, the air, and the tank receiving the fuel can become too great and create a spark. The point at which this occurs is determined by the rate at which the fuel is pumped, temperature, and humidity. This could lead to ignition of any vapors or of the fuel itself.

Equipment

Nearby equipment can create issues when dealing with fuel. If any equipment is running, mechanical or electrical, it can create a spark that could ignite any fuel vapors present. All unnecessary equipment should be turned off or removed from the area. Any necessary equipment should be grounded to the aircraft. Maintenance on nearby aircraft should be halted until defueling and refueling are complete.

Weather

Lack of humidity or convective activity in the area can increase the risk of sparking a fuel fire. Be aware of any weather hazards that may be approaching and postpone defueling operations as necessary to mitigate risk.

Personnel

Personnel can create their own ignition hazards. People can carry static electricity with them through their clothing and should try to dispel any static prior to beginning fueling operations. Unaware personnel may inadvertently utilize other machinery or equipment in the area, or may inhale vapors if standing downwind of ventilation devices. Inappropriate use of checklists and procedures could create additional hazards.

Prevention Strategies

Ventilation

Fuel vapors build quickly and low to the ground. Ventilation should be adequate to properly disperse vapors away from any potential ignition sources and away from personnel and aircraft. Hangar doors should be kept open and fans or a ventilation system should be used during fueling operations.

Drainage

Defueling should be done over an approved fuel drain or an apparatus than can collect any spilled fuel. Fuel can then be easily collected and properly disposed of. Operators should contact their airport to determine the proper disposal methods. A policy and/or procedure should document what needs to happen in the event of spilled fuel.

Removal of ignition sources

Any unnecessary item that could create additional heat, static electricity, or a flame or spark should be turned of or removed from the area. Employee smoking areas should be far enough away and outside to prevent any interference with fuel or fuel vapors. Any other maintenance work that is occurring in the same area should be stopped and associated equipment turned off or removed.

Electrical Bonding (Static Buildup)

Connecting a ground (bonding) wire from the aircraft to the fuel container makes sure a voltage differential cannot develop and reduce the possibility of spark due to static buildup. A cable/ground wire should link to designated points or to clean unpainted metal surfaces on the chosen airframe. Cables should connect to the installation receiving the fuel. All connections should be made before filler caps are removed prior to the start of defueling and then not broken until complete and the caps have been replaced where applicable. It should be noted that fuel hoses **are not** suitable substitutes for dedicated clips and bonding wires.

Equipment

Deadman Switch— If possible, any equipment (such as a fuel pump) used should be equipped with a Deadman switch, which would ensure that any injury to personnel using it results in immediate shutdown of the equipment.

Location—Any fueling equipment, whether located inside or outside, should be positioned so that in the case of a fire, personnel are able to safely and quickly exit and fire-fighting equipment can easily reach the fire. *The National Fire Protection Association Standard (NFPA 418 Standard for Heliports 4.7.2) states that fueling equipment shall be located a minimum of 25 feet from hangars and fixed fire protection equipment.* Operators should also consider the Heliport Design Advisory Circular (FAA AC 150/5390-2C).

Storage

FAA AC 150/5230-4B has definitive regulations on how fuel should be stored, handled, and dispensed on airports, as well as associated training. All operators should review this AC. The regulations follow the standards set by NFPA Standard 407: Standard for Aircraft Fuel Servicing, which also has a specific section (5.14) for defueling. The standard states that defueling procedures should mirror those of fueling the aircraft, and also have cargo tank requirements (4.3.21.7)

Personnel

All personnel near the area or entering the hangar should be notified that defueling (or fueling) is occurring and of the procedures that are in place at that time. Smoking should not be allowed near maintenance hangars. Only trained personnel should be allowed to complete any fueling operations.

Lines of Defense for In-Hangar Fires

Sprinkler System/Foam System

If dealing with fuel or any other combustible materials inside a hangar on a regular basis, the hangar should be equipped with a NFPA approved fire suppression system (NFPA 415). Suppression should be rated for the size of hangar and for the type of materials you are using. The American Fire Protection Group recommends:

- Always check your local building codes
- Group I and II hangars—Foam-water deluge system, with supplementary protection systems under single aircraft wing areas over 3000 ft2 (279 m2). The supplementary protection systems: low-level low-expansion foam system using oscillating monitors or low-level high-expansion foam system; combination of automatic sprinkler protection and an automatic low-level low-expansion foam system; combination of automatic sprinkler protection and an automatic low-level high-expansion foam system.
- Group II hangers—a closed-head, foam-water sprinkler system is also an option.
- Group III hangars—fixed fire protection systems are not normally required. *If there are hazardous operations such as fuel transfer, welding, torch cutting, spray painting, etc. performed in a Group III hangar, the hangar would need to meet the fire protection requirements of a Group II aircraft hangar.*
- Group IV hangars with fueled aircraft—fire protection options for storage and service areas are either: low-expansion foam system, or high-expansion foam system.

Extinguishers

Properly rated fire extinguishers should be located within reach during all fueling operations, including on the fuel pump and in the aircraft.

Extinguishers should be dry chemical. Dry chemical extinguishers put out fires by coating the fuel with a thin layer of fire retardant powder, separating the fuel from the oxygen. The powder also works to interrupt the chemical reaction, which makes these extinguishers extremely effective. Dry chemical extinguishers are usually rated for class B and C fires and may be marked multiple purpose for use in A, B, and C fires. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant. ABC fire extinguishers are red in color, and range in size from five pounds to 20 pounds. Dry Chemical extinguishers will have a label indicating they may be used on class A, B, and/or C fires. *Operators need to determine which extinguisher is best for their operations.*

Fire And Rescue

Operators should have a direct line to the local fire and rescue departments in their area. This may be associated with a Deadman switch, fire suppression system, or call button. All approach areas for fire and rescue should remain clear per fire and building codes. This includes any equipment inside the hangar that could block fire-fighting personnel from adequately reaching the fire, as well as any personnel that may be injured or trapped.

Accident /Incident Review

While the NTSB accidents or incidents that can be directly attributed to defueling operations, thousands of accidents are contributed to by issues related to fueling. A search of the NTSB and FAA databases, as well as the NASA ASRS reports show that improper pre-flight inspections, mistakes in maintenance of fuel systems, and crew not properly refueling the aircraft are key contributors to these events.

A search of the OSHA databases lists numerous accidents dealing with fuel vapors, including one specific to aircraft operations that resulted in a hangar fire with injury and substantial damage (https://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200350171). Another accident dealing with chemical vapors and an electric dryer resulted in the death of an aircraft mechanic and substantial damage (https://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200260818). Numerous other workplace accidents can be found in the OSHA databases when searching for jet fuel, vapors, static electricity, and hangar.

One incident resulted in chemical pneumonia when a mechanic siphoned fuel using suction from his mouth (https://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=201702149). This was contributed to by lack of proper procedure and policy, as well as improper oversight.

Conclusion

This research brief is not designed to be biased, but is rather based on all of the information derived from sources available to PRISM SMS, it can be concluded that It would be safer to perform defueling outside of the hangar away from buildings and with proper ventilation. However, if comprehensive guidelines, policies, and checklists are put into place and followed, the practice of defueling in the hangar may be mitigated to an acceptable risk.

Hangar design, construction, and setup should follow NFPA Standard 409: Standard on Aircraft Hangars and operators should consult with their local fire and rescue departments to design the best procedures in the case of fire or other incident. Heliports should adhere to NFPA Standard 418: Standard for Heliports.

Managers should conduct risk assessments prior to any policy implementation, and conduct training with all personnel that will be involved or in the vicinity (this may include contracted workers, employees, airport personnel, and fire and rescue personnel). A properly completed risk assessment will identify operation-specific hazards and allow the operator mitigate them in a way that does not reduce operational efficiency.

Instruction and training of all crew, maintenance, and line personnel that may be taking part in defueling should include recognition of fuel leaks, vapor accumulation, and ignition prevention as well as the appropriate actions to be taken in the event of fire or explosion. Policies, procedures and training should follow the regulations set forth in FAA Advisory Circular 150/5230-4B, as well as OSHA CFR 1910.39 Fire Prevention Plans.

Resources

Skybrary—Refueling and Defueling Risks
National Fire Protection Association Standards
American Fire Protection Group, Inc.
Occupational Safety and Health Administration
FAA AC 150/5230-4B
Heliport Design Advisory Circular (FAA AC 150/5390-2C)
OSHA CFR 1910.39