



Naval Safety Center

LESSONS LEARNED



19-04

FIREFIGHTING - HAZARDS OF AIRCRAFT COMPOSITE MATERIALS



Today's Navy firefighters are well trained to fight fires and save lives. Those on board ships with aircraft have additional constraints such as space, wind direction and velocity, close proximity to fuel, ordnance, and other hazards, as well as the unique materials of aircraft. Today's aircraft are being built extensively with composite materials due to their high strength to weight ratios. However, this benefit to the aircraft can pose a health hazard to the firefighters when a mishap occurs. Although all fires — especially aircraft — are dangerous, carbon fibers and their associated resins present additional inhalation and dermal hazards.

Take this recent actual example in which highly trained Crash and Salvage personnel learned some valuable lessons when responding to an aircraft fire at sea:

An aircraft carrier was underway when an F/A-18C caught fire after a refueling hose ruptured, spraying atomized fuel towards the engine intake. Within seconds, a fireball engulfed the jet. The pilot ejected safely, but the aircraft suffered Class A mishap damage due to the fire. Fire crews were well trained in the initial response, taking only three minutes to extinguish the fire. Once the fire was out, however, it took time to determine the next stage of the response and clean-up. The mishap squadron's embarked detachment did not include an Emergency Reclamation Team (ERT). A properly trained and equipped ERT could have readily taken control of the scene once the fire was extinguished, thereby minimizing exposure to composite inhalation and other hazardous materials during post-fire inspections of the aircraft. It was not until hours later that the ship's Aviation Intermediate Maintenance Department's (AIMD) ERT was assembled to coordinate with Crash and Salvage to secure the scene and begin making plans to apply wax to the aircraft in accordance with governing guidance. Due to foul weather, the ship's force did not apply the wax until the following morning, thus prolonging unmitigated exposure to hazardous material.

As a result of the mishap, the ship recommended that the Air Department Training Team (ADTT) incorporate post-fire handling of hazardous material procedures into firefighting scenarios. They recommended teaching initial responders how to secure the scene post-fire and then hand over the scene to the ERT. Further recommendations included submission of any necessary changes to the COMNAVAIRFORINST 3500.20 Aircraft Carrier Training and Readiness Manual (CV-TRAMAN), and to ensure future carrier pre-sail briefs included discussion of squadron detachment mishap and ERT responsibilities.

All flight deck personnel, especially Crash and Salvage teams, should be trained on carbon fiber exposure hazards and clean-up. Furthermore, the post-fire actions taken to contain carbon fiber particles and resins apply not only to the firefighters, but also to mishap investigators and assisting personnel.

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One of the specific threats of carbon fibers exposed to fire and/or heat is Methyl Ethyl Ketone Peroxide (MEKP), a liquid catalyst which is used to accelerate fiberglass curing. It can cause permanent blindness from a single, small dose.

[Note: Hazards like this also illustrate the importance of checking the Safety Data Sheet (SDS) for your command's specific hazardous materials (HAZMAT). This also would be useful information in any pre-mishap binder].



The Aircraft Firefighting and Rescue Manual (NAVAIR 00-80R-14, 1 June 2018) lists these potential health concerns that all emergency personnel should consider:

- a. Avoid skin contact with composite dust and particulates.
- b. Fires associated with composite material produce irritating, corrosive, and/or toxic gases.
- c. Avoid inhaling burnt composite material, carbon fiber, and smoke plume gases.
- d. Avoid inhaling dust generated during machining/handling.
- e. Negative effects caused by inhalation or exposure may have a delayed reaction.
- f. Protruding composite materials damaged by impact or explosion present puncture and laceration hazards.
- g. Water runoff from fire extinguishment or dilution attempts may present an environmental hazard.

For fighting the fire, the manual also provides requirements for response personnel to wear a Self-Contained Breathing Apparatus (SCBA) and Proximity Fire Fighting Protective Ensemble (PFFPE). Firefighting personnel should approach and extinguish the fire from the upwind position. After the fire is extinguished, a fiber hazard zone shall be set up that requires either a SCBA or particulate masks for entry. To assist mishap investigators, the manual also states the preferred method of fiber containment is to wrap the damaged parts in plastic sheets (0.006 inch thick, per L-P-378), or place the parts in plastic bags. Tape the sheets/bags in place with aircraft preservation tape, MIL-T-22085, Type II. If this is not feasible, a more permanent containment than that provided by AFFF can be obtained using spray-on fixant, MIL-C-81309, Type II (as specified in the NAVAIR 01-1A-509). Fixant can be applied once all imminent hazards have been mitigated and the composites have cooled to ambient temperature. Mishap investigations officials should grant approval before application begins. Since fixant may mask key fracture surfaces, investigation officials should direct which structures should instead be wrapped in plastic as an alternative to containment with fixant. Fixant spray teams may need to be escorted if the fiber hazard zone is not clear of explosives hazards.

The Naval Safety Center provided additional guidance in GENADMIN message 136-882 (Accident Investigation and Clean-up of Aircraft Containing Carbon/Graphite Composite Material Safety Advisory, DTG 120926Z AUG 93). This advisory provided alternative, locally mixed fixant options with a makeup of 10-parts water to 1-part acrylic floor wax to be applied/sprayed to the applicable areas. To ensure your command has the required material on hand, command safety personnel should coordinate with your shipboard Supply Department or squadron Maintenance Control. The advisory also recommends that investigation and clean-up crews wear TYVEK suits or comparable coveralls, taped at the openings, puncture resistant gloves and/or chemical resistant gloves, steel-toed boots, and non-vented goggles or safety glasses with side shields if a full-face respirator is not used. *[Note: Don't forget the required medical screening, training and fit test as part*

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of your pre-mishap plan]. Once fixant is applied, the fibrous remnants should be placed in a rugged bag or multiple, large trash bags and labelled appropriately as carbon fiber hazardous material with the statement, "COMPOSITE WASTE. DO NOT INCINERATE. DO NOT SELL FOR SCRAP. COMPOSITE WASTE."



Toxicological significance of Methyl Ethyl Ketone Peroxide (MEKP):

-A combustion product of carbon fibers. Chemical Abstract Service Registry Number 1338-23-4

The potential adverse health effects from MEKP exposure include:

-*Inhalation*: irritation (corrosive) to respiratory system and mucous membranes, cough, dyspnea (difficulty breathing, shortness of breath), sore throat, pulmonary edema, laryngitis

-*Dermal*: irritation (corrosive), redness, pain, blisters, severe deep burns (second and third degree) and scarring, dermatitis; may be absorbed through the skin, adverse dermal effects may be delayed

-*Ocular*: irritation (corrosive), redness, pain, severe deep burns, blurred vision, blindness

-Additional target organs: liver, kidneys

-Additional information: MEKP is flammable, reactive, combustible, and explosive

References:

National Center for Biotechnology Information. PubChem Compound Database; CID=3672772
<https://pubchem.ncbi.nlm.nih.gov/compound/3672772> (accessed Feb. 7, 2019)

Haz-Map. TOXNET. National Institutes of Health. U.S. National Library of Medicine
<https://hazmap.nlm.nih.gov/category-details?table=copytblagents&id=550> (accessed Feb. 7, 2019)

Lessons Learned / Best Practices

1. Ensure flight deck personnel, Emergency Reclamation Team members, and mishap investigation team members are trained upon the hazards of composite fibers.
2. Prepare command pre-mishap plans and pre-mishap kits with the proper information and materials to mitigate carbon fiber hazards.