FLIGHT SAFETY FOUNDATION
CABIN CREW SAFETY
Vol. 39 No. 5 *For Everyone Concerned With the Safety of Flight* September–October 2004

Hidden Cabin Fires Require Fast, Aggressive and Improvised Responses

Updated recommendations by international authorities emphasize a mindset, priority-setting and methods that flight attendants require if confronted by signs of an in-flight fire — including invisible/inaccessible flames and smoke/odor from portable electronic devices.

FSF Editorial Staff

Knowing that no two in-flight fires will be identical, aircraft crewmembers must be prepared to discharge the first available fire extinguisher in the cabin without any hesitation.[1] This guidance is part of recently updated recommendations derived from aircraft accident investigations and laboratory research emphasizing strategies and techniques for coping with hidden fires.

If flames are not visible or the fire is relatively inaccessible, these general guidelines call for aggressively searching for the fire source, then discharging the fire-extinguishing agent onto the base of flames or smoldering material.[2] These actions may require flight attendants to quickly locate hot spots (locations with abnormally high temperatures) by feeling along cabin surfaces with the back of the hand,[3] to cautiously open storage compartments or doors, and to consider the possibility that openings may have to be punched or cut into floors, ceilings or sidewall panels.

Invisible/inaccessible fires warrant special attention in emergency procedures and cabin crew training because the source must be recognized and assessed by the crew so that action can be taken before the fire becomes uncontrollable.

The U.S. Federal Aviation Administration (FAA), for example, said that its current Advisory Circular (AC) 120–80, *In-flight Fires,* complements earlier guidance on the most effective methods for extinguishing cabin fires that are readily accessible and earlier guidance on the proper use of cabin fire extinguishers and protective breathing equipment (PBE).

"[Taking immediate and aggressive action] is complicated by the multitude of cabin configurations that are currently in use throughout the industry," FAA said. "For this reason, there is no single formula for fighting/extinguishing in-flight fires."

Familiarity with the hidden areas where fire might occur on a specific aircraft type (Figure 1, page 2) enables flight attendants to accurately describe the emergency to crewmembers who are on the flight deck or in other areas of the cabin. For example, the cheek area[4] of narrow-body aircraft and wide-body aircraft typically contains wire bundles, hydraulic lines and other electrical components. An overhead area[5] typically contains components of the aircraft's entertainment system, wire bundles, control-surface cables, portions of the air conditioning system, the passenger emergency oxygen system and other systems.

"Failure or uncommanded operation of an aircraft component may indicate a developing fire," FAA said. "Electrical connections and the components themselves may have been damaged by a fire in the area of the component or at any point along its power supply line. For this reason, cabin crewmembers should report all failures of electrical items to the flight crew in accordance with company policy. Circuit breaker(s) [CBs] tripping [activating], especially multiple [CBs]

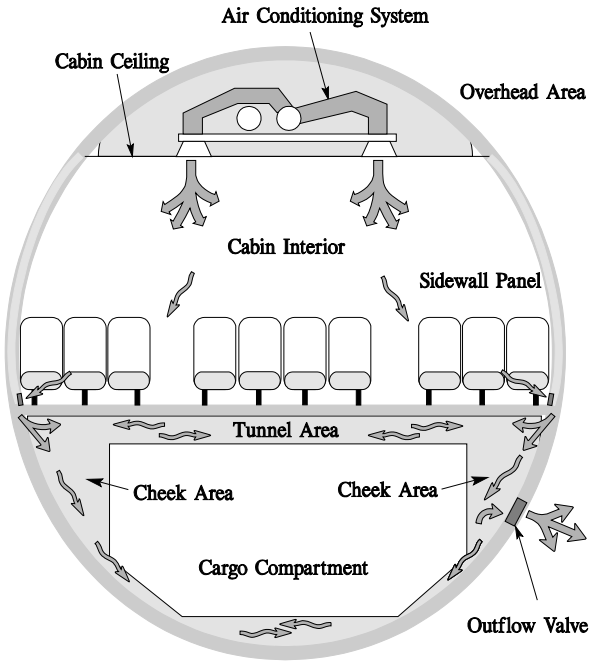

Figure 1

such as entertainment systems, coffee makers, etc. may be an indication of damage occurring in a hidden area common to the affected components.

"Odor … may be one of your first indications of an impending fire. Never ignore a strange odor; you need to identify its source as soon as possible. Smoke coming from vents or seams between interior panels, especially from the ceiling area, is a sure sign of a problem, and you should take immediate action to determine the source. Hot spots on the floor, sidewall, ceiling or other panels should be immediately investigated."

Awareness of known fire causes can help the cabin crew to respond. The following causes of hidden fires, which may be subtle compared with a readily visible fires, were cited:

- Wiring failures, electrical component failures and faulty circuit protection have occurred. "A majority of hidden in-flight fires are the result of electrical arcs along wire bundles," FAA said;
- Lightning strikes very infrequently have ignited an in-flight fire. "In these instances, faulty or contaminated insulation material contributed to the fire," FAA said; and,
- High-temperature bleed-air leaks (i.e., in aircraft with environmental control systems that use air compressed by the engine) have caused in-flight fires and structural damage. "A failure of any of these [pneumatic] supply lines, if left unchecked, can cause high temperatures in the surrounding area and damage to the aircraft's equipment, wiring and associated components," FAA said.

Resourcefulness and persistence in accessing hidden areas within the aircraft can be essential to quickly extinguish an in-flight fire.

"For example, a fire located behind a panel or within a cupboard area in the lavatory probably would not be successfully extinguished by discharging a fire extinguisher into the lavatory without first opening the cupboard or gaining access to the area behind the panel where the fire is located." FAA said. "Depending on the volume of [an] overhead area, discharging a fire extinguisher randomly without attacking the base of the flames or smoldering material probably would have no effect on the fire."

Cutting or punching a hole in an aircraft cabin wall, ceiling or floor panel is appropriate if this is the only way to gain access to the fire.

"In this situation, the risk of damaging equipment behind the paneling and the possibility of creating a bigger problem must be weighed against the catastrophic potential of in-flight fires left unattended," FAA said.

Improvised tools and methods to pull open, pry apart or otherwise separate sidewall panels to access a hidden fire could include the following:

- The manual-release tool designed to open the overhead oxygen-mask compartments (if equipped);
- Galley equipment such as the handle of a casserole pan, ice tongs or metal cutlery;
- Shoehorns, knitting/crocheting needles, walking canes and similar rigid items;
- Items from survival kits attached to a life raft (not an integral part of a life raft); and,
- Access points unique to an aircraft type or cabin configuration, such as cabin-ceiling speaker covers.

Ideally, consideration of resources will encompass unconventional fire fighting aids and fire-extinguishing methods.

"For example, non-alcoholic beverages such as coffee, soda, juice or water may be poured onto a fire," FAA said. "A carbonated beverage may be used as a fire extinguisher by shaking up the can or bottle, opening the top and spraying the contents at the base of the fire. Additionally, wet blankets or pillows may be used as smothering devices to help extinguish a fire and prevent reignition."

Signs of fire should trigger cabin crew actions that take into account the limited quantity of extinguishing agent aboard the aircraft.

"If you suspect a fire in a lavatory, you should immediately notify another crewmember, get the closest fire extinguisher and check the door for heat," FAA said. "Cautiously and slowly open the lavatory door. … If the base of the flames or the source of the fire cannot be readily identified, do not discharge the agent with the intent of suffocating the smoke. This is not an effective way to fight a fire and would only waste valuable extinguishing agent when the source or base of the fire is not accessible."

On aircraft with more than one flight attendant, a team method of fire fighting — in which roles are explicit — should be considered in emergency procedures. Assuming, for example, an aircraft crew comprising three flight attendants and two pilots, the crewmember who finds signs of fire — typically a flight attendant — can act as the firefighter. A second crewmember can act as the communicator, immediately notifying flight deck crewmembers and continually relaying the location, source and severity of the fire (e.g., that the fire is under control, spreading, contained or extinguished), the number of fire extinguishers discharged, smoke conditions and specific actions taken to extinguish the fire. "The communicator also makes announcements to inform and calm the passengers," FAA said. Another crewmember can act as the runner, providing fire fighting support, such as obtaining supplies, relocating passengers, distributing towels for passengers to cover their noses and mouths to filter smoke, and removing oxygen bottles away from the fire area.

Knowing the source of smoke helps the flight crew to safely operate the aircraft environmental control system.

"If the cause of the [cabin-air] pollutant is a fire and the fire has not been extinguished, it is possible to worsen the situation by increasing airflow through the area where the fire or smoldering condition exists," FAA said.

U.S. National Transportation Safety Board (NTSB) investigations of in-flight fires have revealed that U.S. flight attendants and pilots may be hesitant to use halon fire extinguishers, the type most commonly carried. FAA said that halon *will not cause harm to aircraft passengers or crew,* noting NTSB's concern that risks of exceeding the maximum recommended levels of halon have been overemphasized in crewmember training.

"Studies have shown that discharging all of the hand-held halon extinguishers required by regulation in the passenger cabin of an air carrier aircraft will not exceed the maximum concentration levels of halon vapor specified in AC 20-42C [*Hand Fire Extinguishers for Use in Aircraft*; March 7, 1984] or by NFPA [formerly U.S. National Fire Protection Association] 408 [*Standard for Aircraft Hand Portable Fire Extinguishers, 1999 Edition*] guidelines," FAA said. "The toxic effects of a typical aircraft seat fire, for example, far outweigh the potential toxic effects of discharging a halon fire extinguisher."

Failure to aggressively discharge halon to extinguish in-flight fires places the aircraft at risk while the potential harmful effects are negligible, FAA and NTSB said.

Seeking the ideal type of fire extinguisher — such as a halon fire extinguisher when a dry-chemical fire extinguisher is at hand — also is inconsistent with immediate and aggressive action.

"When a fire is discovered, the initial focus should be on extinguishing the fire and then following up with the appropriate class of fire extinguisher," FAA said. "After you have initially suppressed the fire[6] or exhausted the first fire extinguisher, you should use the preferred extinguishing agent for the class of fire to maintain control or [to] extinguish the fire."

Nevertheless, in a few situations, a water fire extinguisher can increase the hazard.

"A water fire extinguisher … should not be discharged directly into a CB panel or an electrical outlet," FAA said. "Nor should water be used to combat a liquid fire (e.g., grease or fuel) that is pooled or has collected on a nonporous surface. The use of [a water fire] extinguisher on a fire fueled by flammable liquids is acceptable if the surface has absorbed the liquid, such as gasoline poured on a seat or other absorbent material."

Various fire extinguishers and fire blankets will extinguish fires involving the battery packs of portable electronic devices (PEDs) without increasing the hazard, based on research conducted for the U.K. Civil Aviation Authority (CAA).[7] If this type of in-flight fire occurs, the cabin crew should anticipate risks such as severe injuries to nearby passengers or crewmembers, cells propelled from the battery pack, flame spreading to adjacent flammable material, and heavy smoke and odor from burned plastic parts continuing after the flame has been extinguished.

Nevertheless, the U.K. CAA report found an extremely low probability that smoke, fire or explosion would be caused by the most common types of rechargeable battery packs during in-flight use or during in-flight charging of PEDs. Multiple failures would have to occur in the circuits built into the battery packs and charger units that, in most PEDs, provide protection against over-current conditions, over-voltage conditions and hazardous temperatures, the report said.

Researchers studied the history of rechargeable battery packs installed in some aircraft safety devices and conducted laboratory testing of various battery packs and representative PEDs.

"The test results have verified the effectiveness of existing fire-extinguishing agents [water, halon, FE-36, ABC dry powder (suitable for solid-material fires, gaseous fires and liquid fires), BC dry powder (suitable for gaseous fires and liquid fires) and fire blankets were tested] in coping with a lithium-ion battery fire," the report said. "Therefore, no further recommendations are made regarding the use of any alternative fire-extinguishing agents."

For laboratory fires involving a lithium-ion battery pack in a laptop computer stored in a plastic carrying case, halon and FE-36 were more effective than water and should be used

first if available. Fire blankets only were effective if they completely enclosed the fire. The PED also should be unplugged immediately from any aircraft power receptacle if possible. "Passengers should be discouraged from plugging in [PEDs] solely for the purpose of charging, to minimize the risk from a battery [fault] or charger fault," the report said. The research has been used to update fire fighting guidance for U.K. cabin crews, and for training purposes has provided video recordings of fire extinguishers operating on PED-battery fires.♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. Federal Aviation Administration Advisory Circular (AC) 120–80, *In-flight Fires,* Jan. 8, 2004. The 21-page report contains a table, an illustration and appendixes.]

Notes

1. Halon 1211 liquefied gas has been the predominant agent approved by civil aviation authorities for hand-held fire extinguishers in transport category aircraft since the early 1980s; water-based fire extinguishers, dry-chemical fire extinguishers and other approved types are used on some aircraft. Halon 1211 has been an effective streaming agent (with flooding capability) against cabin fires. After being linked to destruction of Earth's stratospheric ozone layer, however, its production was halted in 1993, and cabin crews have been prohibited from discharging halon fire extinguishers during training. Replacement agents have been developed for various applications. For example, the U.S. Federal Aviation Administration (FAA) has approved two streaming agents to replace halon 1211 when the hardware–agent combination is certified by Underwriters Laboratories (UL) for transport category aircraft. These are American Pacific Halotron I in Amerex Halotron I fire extinguishers and DuPont FE-36 in Ansul Cleanguard fire extinguishers; both have passed the FAA seat-fire toxicity test and the UL hidden-fire test.

2. FAA said that a smoldering fire is characterized by "combustion without a visible flame and a slow combustion rate."

3. FAA said that carefully touching surfaces with the back of a hand is preferable to using fingers or the palm of a hand. "The skin on the back of your hand is more sensitive to temperature variations than your palm or fingertips," FAA said. "Using the back of your hand allows you to be more aware of temperature fluctuations as you run your hand along a panel, making it easier to locate hot spots on the panel. Also, using the back of the hand protects your palm and fingers from being immobilized in case the object is so hot that it could burn your hand."

4. Spaces just below the floor, outboard of the cargo compartment areas, comprise the cheek area, FAA said.

5. Spaces above the ceiling panels running the length of the fuselage comprise the overhead area.

6. A suppressed fire has been partially extinguished and may or may not have visible flames, FAA said.

7. Lain, M.J.; Teagle, D.A.; Cullen, J.; Dass, V. *Dealing With In-flight Lithium Battery Fires in Portable Electronic Devices.* U.K. Civil Aviation Authority (CAA) Paper 2003/4. July 30, 2003.

Cabin Crew Safety

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, associate editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: One year subscription for six issues includes postage and handling: US$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708