U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: In-Flight Fires

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Initiated by: AFS-200 **Change:**

1. PURPOSE. This advisory circular (AC) updates information regarding the hazards and risks of in-flight fires on transport category aircraft. The information includes recommended crewmember procedures and training for combating in-flight fires. The National Transportation Safety Board (NTSB) issued Safety Recommendations A-11-87 through A-11-91 during the investigation of United Parcel Service (UPS) flight 6 accident on September 3, 2010 in the United Arab Emirates. The flightcrew encountered a "Fire Main Deck" master warning about 22 minutes into the flight; they declared an emergency and initiated a return to Dubai International Airport (DXB). The aircraft crashed inside an Emirate army post 9 miles from DXB, and both flightcrew members were fatally injured. NTSB findings revealed safety issues related to the training and use of oxygen mask; communicating with oxygen masks donned; and oxygen mask stowage and the smoke, fire, or fumes checklists. This revision to AC 120-80 is in response to NTSB recommendations A-11-88 through A-11-90. Specifically, this AC:

- Is applicable to operators certificated under Title 14 of the Code of Federal Regulations (14 CFR) parts 91K, 121, 125, and 135.
- Discusses the importance of flightcrew member initial and recurrent hands-on training, including the use of operable oxygen mask/goggle sets, the use of the regulator's emergency selector, and the venting of smoke goggles.
- Discusses the importance of flightcrew member initial and recurrent hands-on training, including aircraft-specific training on establishing and maintaining internal cockpit communications when the flightcrew members don the oxygen masks.
- Emphasizes the importance of flightcrew members stowing their oxygen masks set to 100 percent.
- Provides guidance for operators' smoke, fire, or fumes checklists to include, as the first step, that flightcrew members don their oxygen masks and verify that the regulator is set to 100 percent.
- Provides guidance to operators on addressing, through procedures and training, the unique characteristics of lithium battery fires.
- Discusses the dangers of in-flight fires, with particular emphasis on hidden fires that may not be visible or easily accessed by the flight or cabin crew. It discusses the importance of recognizing and quickly assessing the conditions that may be associated with hidden fires and the importance of taking immediate action to gain access to fires that are located behind interior panels.

- Provides guidance on how to deal with in-flight fires, emphasizing the importance of flight and cabin crewmembers taking immediate and aggressive action in response to signs of an in-flight fire while stressing the effectiveness of halon extinguishing agents.
- Discusses the importance of appropriate crewmember training in dealing with hidden fires, the effective application of fire extinguishing agents behind interior panels, and the urgency of the crew's action in dealing with such fires.
- Complements guidance previously developed for crewmembers concerning the proper use of cabin fire extinguishers (the current edition of AC 20-42, Hand Fire Extinguishers for Use in Aircraft, and National Fire Protection Association (NFPA) 408, Standard for Aircraft Hand Portable Fire Extinguishers) and the most effective means of extinguishing fires that are readily accessible.
- Includes information from research conducted by the Federal Aviation Administration (FAA) William J. Hughes Technical Center. As additional information becomes available, it will be published in future revisions to this AC.

2. AUDIENCE. Air carriers, FAA personnel (such as aviation safety inspectors (ASI)) and others involved in the development of crewmember training programs, as well as crewmembers and others involved in flight operations under part 121, should be familiar with the contents of this AC. This AC may also be valuable to certificate holders and ASIs associated with operations conducted under parts 91, 125, and 135.

3. USING THIS AC. When tailored to specific aircraft and operators' procedures, the suggested guidelines presented in this AC provide a good framework for defense against in-flight fires. However, approved manufacturer's procedures take precedence over the information presented in this AC. The importance of crewmembers taking immediate and aggressive action to locate the source, gain access, and effectively apply extinguishing agents to hidden fires cannot be overstressed. The multitude of cabin configurations that are currently in use throughout the industry complicates this task. For this reason, there is no single formula for fighting/extinguishing in-flight fires.

4. CANCELLATION. This AC cancels AC 120-80, In-Flight Fires, dated January 8, 2004.

5. RELATED REGULATIONS (14 CFR).

- Part 25, § 25.851
- Part 91, § 91.513
- Part 121, §§ 121.215, 121.221, 121.273, 121.275, 121.308, 121.309, 121.337, and 121.703
- Part 135, §§ 135.170, 135.331, and 135.415

6. DEFINITIONS.

a. Aggressively Pursue. Aggressively pursuing a fire means taking immediate action to determine the source of hot spots, smoke, and/or flames. The crew should quickly evaluate the situation, gain access to the fire, and attack the fire using all available resources, which may include deadheading crewmembers or able-bodied persons (ABP).

b. Cheek Area. This term describes the area just below the floor, outboard of the cargo compartment areas. In narrow and widebody aircraft, this area houses wire bundles, hydraulic lines, and other electrical components. (See Appendix 2, Typical Widebody Cross-Section.)

c. Circuit Breaker. Circuit breakers are designed to open an electrical circuit automatically at a predetermined overload of current.

d. Halon. Halon is a liquefied gas that extinguishes fires by chemically interrupting a fire's combustion chain reaction, rather than physically smothering it. This characteristic is one of the main reasons that halon extinguishers are effective when the exact source of the fire cannot be positively determined. Halon fire extinguishing agents that have been approved for use in aircraft include Halon 1211, Halon 1301, and a combination of the two (Halon 1211/1301). Both are typified as "clean agents," leaving no agent residue after discharge. Approved halon-type extinguishers are three times as effective as carbon dioxide (CO_2) extinguishers with the same weight of extinguishing agent.

(1) Halon 1211. The chemical name is bromochlorodifluoromethane. Halon 1211 is a multipurpose, Class A, B, and C rated agent that is effective against fires fueled by flammable liquids. Halon 1211 fire extinguishers discharge in an 85 percent liquid stream, giving the agent a range of 9 to 15 feet, which offers a significant advantage in fighting fires in large aircraft cabins.

(2) Halon 1301. The chemical name is bromotrifluoromethane. Halon 1301 has Class A, B, and C capability in total flooding systems; however, Halon 1301 has limited Class A capability when used in portable fire extinguishers. The useable range of a Halon 1301 extinguisher is slightly less than that of a 1211 extinguisher.

e. Hidden Fires. Fires that are "hidden" are not readily accessible, may be difficult to locate, and are more challenging to extinguish. Some examples of hidden fires would be fires behind sidewall paneling or in overhead areas.

f. Lithium Battery. Types of batteries commonly used to power consumer portable electronic devices (PEDs). There are two types of lithium batteries, disposable and lithium-ion batteries (rechargeable).

g. Overhead Area. Area within the aircraft fuselage located above the ceiling panels. This area ranges in volume, depending on the aircraft type. In a narrowbody transport, this area may be only several inches high running the length of the fuselage. In widebody aircraft, however, this volume is much larger, and may range in height from two to four feet or more. A typical overhead area contains components of the aircraft's entertainment system, numerous wiring bundles, control surface cables, portions of the air conditioning system, passenger emergency oxygen system, and other systems. (See Appendix 2, Typical Widebody Cross-Section.)

h. Return Air Grills. These are vents located along the baseboard area of each sidewall of the passenger cabin. Most transport category aircraft have air conditioning systems that supply conditioned air near the cabin ceiling. This air flows in a top-to-bottom direction, exiting through the return grills, and eventually out the fuselage via the outflow valve(s).

i. Recirculation Fan. These units are typically located in the overhead area, and recirculate air in this space, to prevent elevated temperatures, and to remove stagnant air.

j. Smoldering Fire. Combustion without a visible flame and a slow combustion rate are characteristics of a smoldering fire. A smoldering fire left unattended or an incompletely extinguished fire can ignite and grow into a larger, uncontrollable fire in a short time.

k. Suppressed Fire. A fire that has been partially extinguished which may or may not have visible flames. A suppressed fire, if not extinguished, may reestablish itself and grow into a larger, uncontrollable fire in a short period of time.

l. Water (H_20) Extinguisher and Other Aqueous-based Extinguishing Agent. Class A type fires are best controlled with water or aqueous based agents by cooling the material below its ignition temperature and soaking the material to prevent re-ignition. Water (H20) extinguishers are designed with a CO2 cylinder in the handle to pressurize the water and antifreeze mixture inside. The use of water extinguisher or any aqueous based extinguishing agent is also highly effective for passenger supplied or hand held portable electronic devices (PED) lithium battery fires. Water, aqueous based extinguishing agent or any non-flammable liquid sprayed on the PED to cool the cells in the battery had been demonstrated to be effective to prevent the propagation of thermal runaway.

7. RELATED READING MATERIAL (current editions.)

a. FAA Documents.

- AC 20-42, Hand Fire Extinguishers for Use in Aircraft.
- AC 25-9, Smoke Detection, Penetration, and Evacuation Tests and Related Flight Manual Emergency Procedures.
- AC 25-16, Electrical Fault and Fire Prevention and Protection.
- AC 120-48, Communication and Coordination Between Flight Crewmembers and Flight Attendants.
- SAFO 09013, Fighting Fires Caused by Lithium Type Batteries in Portable Electronic Devices.
- FAA Order 8900.1, Flight Standards Information Management System (FSIMS) chapters and sections that address cabin safety issues and emergency procedures.

b. Related Research Material. You can obtain the following documents from various public sources such as the Web, public and university libraries, and the government entities or associations who published them.

- A Benefit Analysis for Enhanced Protection from Fires in Hidden Areas on Transport Aircraft, DOT/FAA/AR-02/50, CAA Paper 2002/01, Report prepared by R G W Cherry and Associates.
- In-Flight Aircraft Seat Fire Extinguishing Tests (Cabin Hazard Measurements), DOT/FAA/CT-82/111, Hill, R.G., and Speitel, L., December 1982.
- Effectiveness of Flight Attendants Attempting to Extinguish Fires in an Accessible Cargo Compartment, DOT/FAA/AR-TN99/29, Blake, D.R., April 1999.

- Halon Extinguishment of Small Aircraft Instrument Panel Fires, DOT/FAA/CT-86/26, Slusher, G.R., Wright, J.A., and Speitel, L.C., December 1986.
- NFPA 408, Standard for Aircraft Hand Portable Fire Extinguishers, 1999 Edition.
- NFPA 12B, Standard on Halon 1211 Fire Extinguishing Systems, 1990 Edition.
- Halon 1211-Exposure Hazards, Ansul Technical Bulletin Number 47, 1980.

8. SUBTLE CAUSES OF IN-FLIGHT FIRES.

a. Wiring Failures. A majority of hidden in-flight fires are the result of electrical arcs along wire bundles. In most cases, the electrical arc acts as the initiating event, igniting other surrounding materials. The surface of insulation materials is often a conveyer of these initiating events, as contamination from spillage, accumulated dirt/dust, lubrication or corrosion inhibitors on these surfaces can promote flame spread (uncontaminated insulation materials are generally very fire-resistant). In other instances, the resetting of a tripped circuit breaker can overheat wiring, ultimately leading to failure and arcing, causing the same chain of events.

b. Electrical Component Failures. Electrical motors can overheat, bind, fail, and possibly ignite surrounding materials. An accumulation of contaminants in the immediate area exacerbates the spread of fire in these instances.

c. Lightning Strikes. Although very infrequent, there have been instances in which a lightning strike has initiated a fire. In these instances, faulty or contaminated insulation material contributed to the fire.

d. Bleed Air Leaks. Aircraft with systems that use air from the engine (bleed air) depend on a series of pneumatic lines to deliver the air supply. A failure of any of these supply lines, if left unchecked, can cause high temperatures in the surrounding area and damage to the aircraft's equipment, wiring, and associated components. High-temperature bleed air leaks have caused in-flight fires and structural damage.

e. Faulty Circuit Protection. A malfunctioning circuit breaker that does not open (trip) when it detects an abnormally high current draw may cause the affected unit or associated wiring to overheat and ignite.

f. Lithium Ion Batteries. Rechargeable lithium ion batteries are capable of overheating, leading to a process called thermal runaway, which can cause the sudden release of the contents of the battery as a flaming jet, heavy smoke, unburned hydrocarbons, or in some cases the battery can explode or rocket. Once one cell in a battery pack goes into thermal runaway, it produces enough heat to cause adjacent cells to go into thermal runaway. The resulting fire can flare repeatedly as each cell ruptures and releases its contents.

9. INDICATIONS OF HIDDEN FIRES.

a. Abnormal Operation or Disassociated Component Failures. Failure or uncommanded operation of an aircraft component may indicate a developing fire. Electrical connections and the components themselves may have had damage from 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 flightcrew in accordance with company policy.

b. Circuit Breakers. Circuit breaker(s) tripping, especially multiple breakers such as entertainment systems or coffee makers may be an indication of damage occurring in a hidden area common to the affected components.

c. Hot Spots. Hot spots on the floor, sidewall, ceiling, or other panels should be immediately investigated.

d. Fumes. This 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.

e. Visual Sighting of Smoke. 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.

10. RESOURCES AVAILABLE FOR FIGHTING IN-FLIGHT FIRES. The available resources depend on the aircraft's specific cabin configuration, which may vary within types. Therefore, crewmembers should include this subject in crew briefings as suggested in the current edition of AC 120-48, Communication and Coordination Between Flight Crewmembers and Flight Attendants.

a. Firefighting Tools. In addition to the aircraft's required emergency equipment, crewmembers should also consider those items not normally thought of as firefighting aids. For example, the crewmember may pour non-flammable liquid such as coffee, soda, juice, or water onto a fire. When extinguishing a suspected electronic device fire, douse the device with water, an aqueous based extinguishing agent, or other non-alcoholic liquids to cool the device and prevent additional battery cells from reaching thermal runaway. You may use a carbonated beverage 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 help smother a fire and prevent re-ignition. Any of these suggestions may prove to be effective as possible firefighting methods. These examples are not meant to be all-inclusive, and crewmembers should consider what other items might be useful.

b. Able-Bodied Passengers. Crewmembers should consider deadheading crewmembers and able-bodied passengers as additional resources when combating a fire. The ability to enlist the help of qualified individuals, especially on a single F/A operation, might be very valuable in combating a fire and communicating with the flight deck crewmembers. Regardless of the type of operation, crewmembers should consider and use all available resources when faced with an in-flight fire.

11. FIRE EXTINGUISHERS.

a. Type of Fire Extinguisher to Use. Immediate and aggressive action when confronted with a potential fire is much more important than delaying while you attempt to classify a particular fire. As a general rule, halon fire extinguishers are your best choice, since halon is classified as a multipurpose (Class A, B, & C fires) agent.

(1) Initial Focus. Upon discovering a fire, the initial focus should be on aggressively extinguishing the fire with a readily available extinguisher (which will likely be halon), but *do not* use water if it is believed the fire is of aircraft electrical system origin. Generally, you should consider using the first available extinguisher rather than delaying your firefighting efforts while you locate a particular extinguishing agent for a class A, B, or C fire. After you have initially suppressed the fire or exhausted the first fire extinguisher, you should use the preferred extinguishing agent for the class of fire to maintain control or extinguish the fire. (See Appendix 4, Information on Using Hand Fire Extinguishers.)

(2) Exceptions. There are a few exceptions to this general guidance. You should not discharge a water fire extinguisher (H_2O) directly into a circuit breaker panel or an electrical outlet. Nor should you use water to combat a liquid fire (e.g., grease or fuel) pooled or collected on a non-porous surface. The use of an H_2O 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.

b. Keep Hand-Held Fire Extinguishers Upright. Hand-held fire extinguishers are designed to be used in the upright position. Most extinguishers have been designed with a center siphon tube that extends to the bottom of the canister. Placing a fire extinguisher on its side or upside down prevents the agent from flowing through the tubing, which has been designed to collect the agent from the bottom of the canister. Laying the extinguisher on its side or turning it upside down to aim at the ceiling may limit the amount of extinguishing agent that is available to be discharged, thereby reducing the extinguisher's firefighting capacity. Consequently, fire extinguishers equipped with flexible discharge hoses and nozzles are better suited to handle fires that may require discharging the agent in an upward direction or in any other situation requiring flexibility. The installation and use of fire extinguishers with flexible hoses is highly desirable for these reasons.

12. HALON EXPOSURE. Generally speaking, halon is not harmful to passengers and crew; however, various publications, including AC 20-42, caution against exposure to "high levels" of halon in confined spaces, citing the possibility of dizziness, impaired coordination, and reduced mental sharpness. AC 20-42 also provides guidelines that describe what is meant by the term "high level" and further states that these levels should not be exceeded in ventilated or nonventilated passenger compartments on aircraft. However, 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 20-42 or by NFPA 408 guidelines.

a. NTSB Investigations. NTSB investigations of in-flight fires indicate that crewmembers have been hesitant to use halon extinguishers during flight because of mistaken ideas about adverse effects of halon. In one instance, an F/A went to the flight deck to inform the flightcrew of a fire and asked the captain whether to spray halon into a vent where she suspected a fire. The captain instructed her not to use the halon extinguisher, indicating he was concerned about spraying halon in the cabin. In another instance, an off-duty company pilot considered using a halon fire extinguisher, but decided against doing so because he was concerned that the halon "would take away more oxygen." In each instance, the crewmembers lost critical time and delayed the aggressive pursuit of the fire.

b. NTSB Recommendation. The NTSB has expressed concern that crewmember training programs have overemphasized the risks of exceeding the maximum recommended levels of halon gas outlined in AC 20-42, especially when compared to the risks of an in-flight fire. The NTSB emphasizes "…that the potential harmful effects on passengers and crew [of Halon] are negligible compared to the safety benefits achieved by fighting in-flight fires aggressively." The toxic effects of a typical aircraft seat fire, for example, far outweigh the potential toxic effects of discharging a halon fire extinguisher.

13. QUESTIONS FOR ALL CREWMEMBERS TO CONSIDER.

a. How Critical are Small In-Flight Fires? In-flight fires left unattended, particularly those that are not readily accessible, may lead to catastrophic failure and have resulted in the complete loss of airplanes. Fire tests conducted by various regulatory authorities have shown that fires allowed to spread into the aircraft's overhead area may become uncontrollable in as few as 8–10 minutes. Studies have also shown that a flightcrew may have as few as 15–20 minutes to get an aircraft on the ground if the crew allows a hidden fire to progress without any intervention. Appendix 3, Time to Becoming Unsurvivable, provides various illustrations of the time from the first indication to the crew of the presence of a hidden fire until it becomes catastrophically uncontrollable. These studies and other experience indicate that flightcrew members should begin planning for an emergency landing as soon as possible after the first indication of fire. Delaying the aircraft's descent by only a couple of minutes might make the difference between a successful landing and evacuation, and the complete loss of an aircraft and its occupants.

b. As a Crewmember, What Should I Do if I Suspect a Hidden Fire? In accordance with company policies and procedures, coordinate with other crewmembers as applicable and take immediate and aggressive action to locate and extinguish the fire.

c. Is it Necessary that I Locate the Exact Source of a Fire Before Applying Extinguishing Agent? There have been several incidents where fires have been extinguished with a stream of halon by discharging the fire extinguisher into the air return grills (fire beneath floor) or into the overhead area. Even if the crew cannot see the fire they should attempt to discharge the extinguisher to where they think the fire is located if access is possible.

d. Should Holes be Cut or Punched in an Aircraft Cabin Wall, Ceiling, or Floor Panel in Order to Gain Access to a Fire? If this is the only way to gain access to the fire, yes. In this situation, crewmembers must weigh the risk of damaging equipment behind the paneling and the possibility of creating a bigger problem against the catastrophic potential of in-flight fires left unattended.

e. What Resources Can I Use to Access Hidden Fires? Consider all available resources to access a hidden fire. Items found in carry-on baggage might be useful nontraditional resources, such as a shoehorn, knitting or crocheting needles, walking canes, and fairly rigid items that could pry apart paneling. One of the best defenses is to be familiar with the interior configuration of the specific aircraft. This familiarity provides clues as to what tools would be most effective when trying to gain access to hidden areas of the aircraft. For example:

(1) Some aircraft are equipped with a manual release tool that is designed to open the oxygen compartments. Crewmembers may use this device to separate or pull apart sidewall panels to permit access to a hidden fire.

(2) Some aircraft have cabin ceiling speaker covers that are removable by simply snapping them out of their fixture. The removal of theses covers provides access to the overhead in the immediate area of the speaker fixture.

(3) Equipment located in raft survival kits that are not an integral part of a survival raft may be useful for gaining access to hidden fires.

(4) Galley equipment such as casserole or ice tongs, metal cutlery, or similar items may be useful in separating interior panels.

(5) One of the most important elements in successfully combating an in-flight fire is an individual's own resourcefulness and determination in accessing hidden areas within the aircraft.

f. What is the Best Way to Locate Hot Spots on a Door or Interior Panel Before Attempting to Open or Remove It? While there is no single best method, we suggest using the back of your hand instead of your fingers or palm. The skin on the back of your hand is more sensitive to temperature variations than your palm or fingertips. 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. Using the back of the hand protects your palm and fingers from immobilization in case the object is so hot that it could burn your hand. For example, if you were to grasp a hot door handle (e.g., lavatory door) using the palm of your hand, there is the possibility of burning your hand. A burned hand would make your firefighting activities more difficult and could cause a delay in extinguishing the fire and conducting an evacuation of passengers.

g. As a Crewmember, if I Suspect a Fire in a Lavatory, What Action Should I Take?

(1) 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.

(2) Cautiously and slowly open the lavatory door. Try to locate the source of the fire and discharge the fire extinguisher at the base of the fire. If you cannot clearly identify the source of the fire, aggressively attempt to locate the cause of the smoke and extinguish the fire. If the base of the flames or the source of the fire is not readily identifiable, 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. Remember, it is critically important that you protect yourself from the effects of smoke and fumes while attempting to fight a fire. Do not enter an enclosed area or begin to battle a fire that is generating heavy smoke without first donning your Protective Breathing Equipment (PBE). A small fire can quickly grow to be large and uncontrollable. Time is critical when combating an in-flight fire; you must use every available resource to locate and extinguish it. Research has shown that a fire left uncontained can destroy an aircraft in as few as 20 minutes and a smoke-filled cabin can be completely consumed by fire in as few as 6–10 minutes.

h. What are the Recommended Procedures for Fighting a Lithium Battery Fire? The following procedures are recommended for fighting a fire in a lithium-type-battery-powered PED. The procedures consist of two phases: extinguishing the fire, and cooling the remaining cells to stop thermal runaway.

(1) Utilize a halon, halon replacement, or water extinguisher to extinguish the fire and prevent its spread to additional flammable materials.

(2) After extinguishing the fire, douse the device with water, an aqueous-based extinguishing agent, or other nonalcoholic liquids to cool the device and prevent additional battery cells from reaching thermal runaway.

WARNING: Do not attempt to pick up and move a smoking or burning device! You may be injured.

WARNING: Do not cover the device or use ice to cool the device. Ice or other materials insulate the device, increasing the likelihood that additional battery cells will reach thermal runaway.

14. FLIGHTCREW ACTIONS IN THE EVENT OF A CABIN FIRE. The flightcrew should do the following:

- Immediately don protective equipment.
- Plan for an immediate descent and landing at the nearest suitable airport.
- Do not use smoke/fume elimination procedures to combat a fire.
- Do use smoke/fume elimination procedures to evacuate pollutants.
- Do not reset circuit breakers, unless required for safe flight.

a. Emergency Landings. Technical evaluations and actual experience indicate that flightcrew members should immediately follow company-approved emergency procedures, notify ATC, and begin planning for an emergency landing as soon as possible. Delaying descent by only a couple of minutes may make the difference between a successful landing and evacuation and complete loss of the aircraft.

b. Notification. If there is a fire, pilots should notify the F/A(s) to prepare the passengers for an emergency landing and evacuation in accordance with company procedures and, if appropriate, assist in fighting the fire.

c. Checklists. Smoke, fire, or fumes checklists should include, as the first step, that flightcrew members don their oxygen masks and verify that the regulator is set to 100 percent. Flightcrew members must don smoke goggles and oxygen masks at the first indication of smoke or fumes and before accomplishing any abnormal or emergency procedures associated with smoke or fume elimination in accordance with your company's approved procedures and/or the manufacturer's recommendations. Any delay might result in a crewmembers' inability to breathe and/or see.

d. Smoke and Fume Elimination. Smoke and fume elimination procedures are designed primarily to evacuate the cabin of foreign pollutants. These procedures are not designed to eliminate the cause of the pollutant but rather to increase the aircraft's airflow to evacuate the pollutant. If the cause of the pollutant is an unextinguished fire, it is possible to worsen the situation by increasing airflow through the area where the fire or smoldering condition exists. For this reason, it is important to extinguish the fire first. If the original source of the fire cannot be determined, exercise caution when attempting to eliminate smoke and fumes from the aircraft. Your best defense as a flightcrew member is to have a good understanding of your aircraft's ventilation and/or pressurization systems and the location of major components within the fuselage. You must not delay taking corrective action in accordance with company-approved procedures for any reason.

e. PBE Use. If additional crewmembers, especially flightcrew members, are required to assist in fighting a cabin fire, the FAA recommends they don PBEs before leaving their duty station. When a team is needed to fight a fire, at least one person with a PBE should be present.

15. F/A ACTIONS IN THE EVENT OF AN IN-FLIGHT FIRE. Company procedures should specify how to handle a fire emergency and it is recommended that F/As do the following:

- Be aggressive; if flames are visible, fight the fire immediately.
- Someone must immediately notify the flightcrew to describe the fire, smoke, smells, action being taken, etc.
- If flames are not visible, find the base or source of the smoke.
- Pull circuit breakers, in applicable area.
- Do not reset circuit breakers, unless instructed by flight crew.
- Relocate passengers as necessary.
- Locate hot spots using the back of your hand.
- Don PBE (not necessarily in this order).

a. Team Approach. One method that may be beneficial is to consider using a team approach to combat a fire. The team approach consists of using flightcrew and multiple F/As to assist in combating the fire. The team approach is modifiable to fit any number of participants greater than one.

(1) Firefighter. The crewmember (typically an F/A) who finds the fire is usually the person who is the firefighter. The firefighter aggressively attempts to locate the source of the fire, fights the fire, and actively tries to extinguish the fire.

(2) Communicator. A second crewmember may serve as a communicator. The communicator relays factual information to the flight deck including the location, source, and severity (e.g., is the fire under control, spreading, contained, extinguished) of the fire, the number of fire extinguishers used, smoke conditions, and what is being done to extinguish the fire (prying apart paneling, discharging an extinguishing agent into the sidewall or overhead).The communicator also makes announcements to inform and calm the passengers.

(3) Runner. Another crewmember serves as a runner. The runner assists by:

- Obtaining additional firefighting supplies,
- Relocating passengers,
- Distributing towels for passenger's use to cover their noses or mouths to filter out smoke,
- Ensuring aircraft and or therapeutic oxygen bottles are moved out of the immediate area, and
- Generally assisting with firefighting support activities as may be required.

b. Single F/A Operation. In a single-F/A operation, when a fire is suspected, immediate communication and coordination with the flight deck is critical. Be sure to follow established company procedures. The F/A performs a variety of tasks with the most important being aggressively pursuing and extinguishing the fire.

16. FAA POLICY ABOUT RESETTING TRIPPED (POPPED) CIRCUIT BREAKERS IN FLIGHT.

a. Resetting Circuit Breakers in Flight.

(1) The FAA reiterates its concern about resetting circuit breakers during flight. Crewmembers may create a potentially hazardous situation if they reset a circuit breaker without knowing what caused it to trip. You should not reset a tripped circuit breaker in flight unless doing so is consistent with explicit procedures specified in the approved operating manual used by the flightcrew or unless, in the judgment of the captain, resetting the circuit breaker is *absolutely* necessary for the safe completion of the flight. A detailed entry in the aircraft's maintenance log is a proven safety practice for tracking purposes, and may provide maintenance personnel with key information to enable prompt troubleshooting and effective corrective action on the ground.

(2) Air carrier manuals and training programs should contain company policies and explicit procedures regarding resetting tripped circuit breakers, both during flight and on the ground. The procedures shown in the manuals used by the air carrier's crewmembers, maintenance personnel, and airplane ground servicing personnel should be consistent with the airplane manufacturer's guidance. You should remind crewmembers not to use a circuit breaker as a switch to perform procedural functions unless doing so is specified in approved company procedures or manufacturer's operating procedures.

b. Potential Hazards Associated with Tripped Circuit Breakers. The FAA has published guidance material that states that circuit breakers are slow-acting devices and may not offer sufficient disconnect protection during events such as arc tracking or insulation flashover. Arc tracking is a phenomenon in which a conductive carbon path forms across an insulating surface. The carbon path provides a short circuit path through which current can flow (e.g., electrical arcing). The effects of electrical faults can include:

- Component overheating;
- Toxic fumes;
- Smoke;
- Fire;

- Damage to wires, wire bundles, or parts;
- Melting of holes in sheet metal parts by faulted, high-current feeder cables;
- Melting and burning of titanium bleed air ducts by a chafed, high-current feeder cable;
- Electromagnetic interference (EMI) with equipment; and
- The simultaneous and unreasonable loss of both engine-driven generators in a two-engine airplane.

NOTE: The current edition of AC 25-16, Electrical Fault and Fire Prevention and Protection, contains additional information about this subject.

c. Using a Circuit Breaker as an On/Off Switch. Since circuit breakers are designed to open an electrical circuit automatically at a predetermined overload of current, they should not be used for day-to-day operational functions because they would not be performing their intended function, which is protection against overloads. You should not use circuit breakers, even those suitable for frequent operation, as a switch to turn protected items on or off. An air carrier should publish and include in its approved maintenance programs and flight operations manuals any exceptions to this procedure.

17. RECOMMENDED TRAINING.

a. Training Programs. Certificate holders' crewmember training programs should stress the importance of crewmembers taking immediate and aggressive action when confronted with smoke, fumes, and in-flight fires. It should also emphasize accessing and fighting hidden fires.

b. Training. Operators should include the following knowledge and skill objectives in their crewmember training programs:

(1) Knowledge-based Objectives.

(a) In the event of a known or suspected in-flight fire, crewmembers must know how to take immediate and aggressive action to locate the source of fires.

(b) To assist crewmembers in locating the source of fires, they must know the various aircraft cabin configurations (e.g., overhead, sidewall, cheek, and tunnel areas) that they are required to operate.

(c) Crewmembers must understand the proper methods and/or techniques to gain access to areas that may support hidden fires and the location of any cabin panels that are removable without special tools.

(d) Each flightcrew member must understand the aircraft ventilation systems, including normal and abnormal procedures, with emphasis on the potential effects of airflow on hidden fires.

(e) To assist flightcrew members in maintaining internal cockpit communications when they don oxygen masks, they must know the aircraft-specific methods for establishing communication.

(f) Each flightcrew member must know the importance of stowing their oxygen masks set to 100 percent.

(g) To enable crewmembers to locate critical equipment components within the fuselage area, operators' manuals should contain a cross-section of the aircraft's fuselage showing the location of electrical, fuel, and hydraulic lines.

(h) Potential indications of hidden fires and the importance of not arbitrarily resetting circuit breakers.

(2) Skill-Based Objectives.

(a) Flightcrew members should practice the procedures and/or techniques associated with:

- Planning for an immediate descent and landing at the nearest suitable airport;
- Aggressively locating the source of smoke, fumes, and fire;
- Notifying the cabin crew under non-normal circumstances;
- Operating the aircraft with the use of protective breathing equipment and smoke goggles;
- Implementing smoke and fume elimination procedures;
- Alternate means of dispersing smoke and fumes when the source of a fire is unknown; and
- Use of oxygen mask/goggle sets including the use of regulator's emergency selector and the venting of smoke goggles.

(b) Cabin crewmembers should practice the procedures and/or techniques associated with:

- Aggressively locating the source of the fire,
- Selecting the appropriate extinguishing agent,
- Relocating passengers as necessary,
- Opening storage compartments or doors,
- Consider location of portable oxygen bottles and consider relocating portable oxygen bottles away from source of fire,
- Notifying the flight crew under non-normal circumstances, and
- Locating hot spots on interior panels.

(c) Skill-based training should be conducted jointly (pilots with F/As) to emphasize crew resource management. Crewmember performance should be evaluated in the following areas:

- Clear concise communication
- Effective decision making
- Critical CRM skills including situational awareness
- Time management

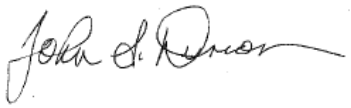
18. OBTAINING FAA PUBLICATIONS.

a. You can find this AC on the FAA's Web site at http://www.faa.gov/regulations_policies/advisory_circulars/.

b. FAA Handbooks and Orders are available online at http://fsims.faa.gov

c. The Code of Federal Regulations is available online at http://www.gpo.gov/fdsys/.

19. NOTES ON APPENDICES. The following appendices contain information about the dangers associated with in-flight fires. Operators may also use this information to develop training programs in support of the recommendations contained in this AC. The information does not represent a rigid FAA view of best practices, which may vary among fleets and among certificate holders, and may change over time. Some of the examples may be readily adapted to a certificate holder's training and operating manuals for various airplane fleets. Others may apply to a certain airplane fleet and may not be adaptable apart from that fleet.



John S. Duncan
Director, Flight Standards Service

APPENDIX 1. NTSB ACCIDENT REVIEWS

This advisory circular (AC) was originally issued in part based on the National Transportation Safety Board's (NTSB) review of commercial aviation accidents involving in-flight fires. The scope of the review was limited to transport category airplanes operated by U.S. and foreign air carriers during the period 1983 to 2000. What follows is a brief synopsis of the events the NTSB reviewed, as well as more recent in-flight fire events.

- On June 2, 1983, a McDonnell Douglas DC-9 operated by Air Canada as flight 797 experienced an in-flight fire and made an emergency landing at Cincinnati and Northern Kentucky International Airport, Covington, KY. A passenger noticing a strange smell and a flight attendant (F/A) seeing smoke in one of the lavatories initially detected the fire. Another F/A saw that the smoke was coming from the seams between the walls and ceiling in the lavatory. During the descent, the smoke increased and moved forward in the cabin. After the airplane landed, F/As initiated an emergency evacuation. Of the 41 passengers and 5 crewmembers on board, 23 passengers were unable to evacuate and died in the fire. The airplane was destroyed.

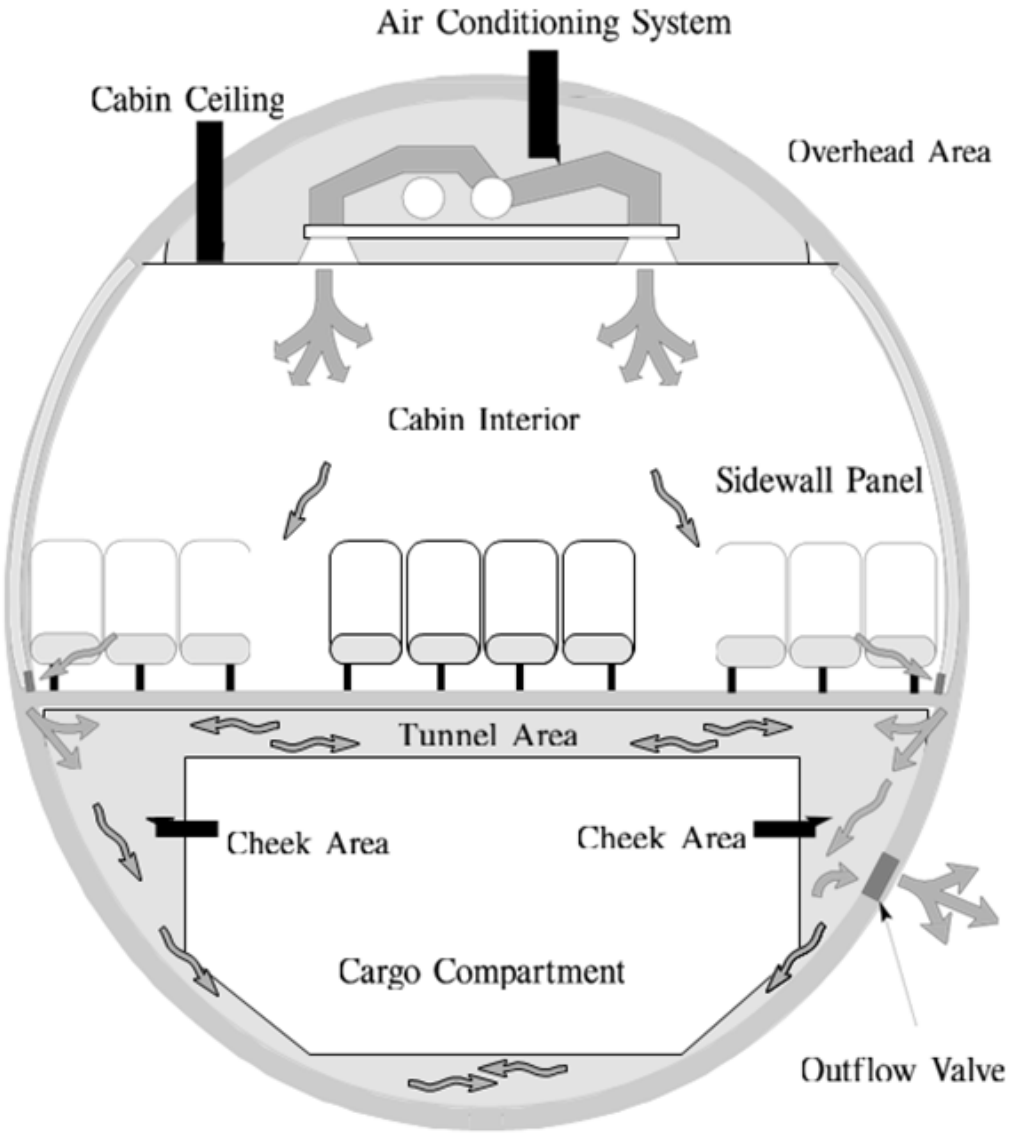
- On September 17, 1999, a McDonnell Douglas MD-88 operated by Delta Air Lines experienced an in-flight fire and made an emergency landing at Cincinnati and Northern Kentucky International Airport, Covington, KY. The airplane sustained minor damage. There were no injuries to the 2 flightcrew members, 3 flight attendants (F/A), 3 off-duty F/As, and 113 passengers during the evacuation.

- On August 8, 2000, a McDonnell Douglas DC-9-32 operated by Air Tran Airways as flight 913 experienced an in-flight fire and made an emergency landing at Greensboro Piedmont-Triad International Airport, Greensboro, NC. The effects of fire, heat, and smoke substantially damaged the airplane. Of the 57 passengers and 5 crewmembers on board, 3 crewmembers and 2 passengers received minor injuries from smoke inhalation, and 8 other passengers received minor injuries during the evacuation.

- On November 29, 2000, lightning struck a McDonnell Douglas DC-9-82 operated by American Airlines as flight 1683, which experienced an in-flight fire that began shortly after takeoff from Reagan National Airport, Washington, DC. The flightcrew made an emergency landing at Dulles International Airport and ordered an evacuation. The airplane sustained minor damage. There were no injuries to the 2 pilots, 3 F/As, and 61 passengers during the evacuation.

APPENDIX 2. TYPICAL WIDEBODY CROSS-SECTION

Although the following diagram represents a typical widebody aircraft, many narrowbody aircraft have the same general layout and ventilation airflow. Other than the cabin height and width, the main difference between widebody and narrowbody aircraft is the volume of free space in the overhead area. This free space can range from a few feet to more than four feet in wide body aircraft and to a little as a few inches in small regional jets. Crewmembers must understand the volume of overhead space in a particular aircraft to effectively combat hidden fires in this area.



APPENDIX 3. TIME TO BECOMING NONSURVIVABLE[1]

The following chart depicts the time that various crews had from the first indication of the presence of a hidden fire to the time that fire became catastrophically uncontrollable.

DATE	LOCATION	AIRCRAFT TYPE	TIME TO BECOME NON-SURVIVABLE (MINUTES)
07-26-1969	BISKRA, ALGERIA	CARAVELLE	26
07-11-1973	PARIS, FRANCE	B-707	7
11-03-1973	BOSTON, USA	B-707	35
11-26-1979	JEDDAH, SAUDI ARABIA	B-707	17
06-02-1983	CINCINNATI, USA	DC-9	19
11-28-1987	MAURITIUS, INDIAN OCEAN	B-747	19
09-02-1998	NOVA SCOTIA, CANADA	MD-11	16

For aircraft with hidden fires, an approximate assessment is that only one third will reach an airfield before the fire becomes uncontrollable.[2]

[1] CAA PAPER 2002/02, (FAA Reference DOT/FAA/AR-02/50), "A Benefit Analysis for Enhanced Protection from Fires in Hidden Areas on Transport Aircraft, p." 6

[2] CAA PAPER 2002/02, (FAA Reference DOT/FAA/AR-02/50), "A Benefit Analysis for Enhanced Protection from Fires in Hidden Areas on Transport Aircraft," p. 20

APPENDIX 4. INFORMATION ON USING HAND FIRE EXTINGUISHERS

The following information has been extracted from AC 20-42, Hand Fire Extinguishers for Use in Aircraft (current edition), and presented here for your review and ease of reference. The information presented below is current as of the date of this AC. However, this Appendix will not necessarily be updated. To ensure you have current information relating to hand fire extinguishers for use in the aircraft you should refer to the current edition of AC 20-42.

1. Types of Fires. To select an appropriate extinguisher for use in an aircraft, consider the following classes of fires (as defined in the National Fire Protection Association (NFPA) Standard 10) that are likely to occur:

a. Class A. Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and plastics, for which the quenching and cooling effects of quantities of water, or aqueous-based extinguishing agents containing a large percentage of water, are of prime importance.

b. Class B. Fires in flammable liquids, oils, greases, tars, oil-based paints, lacquers, and flammable gases, for which extinguishing agents having a blanket effect are essential.

c. Class C. Fires involving energized electrical equipment and where the electrical nonconductivity of the extinguishing agent is important.

d. Class D. Fires involving combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium, which require extinguishing agents of the dry powder types. You should follow the recommendations of the manufacturer for use of those extinguishers to avoid possible chemical reaction between the burning metal and the extinguishing agent.

2. Extinguishing Agents Appropriate for Types of Fires. The following extinguishing agents are recommended, as appropriate, for use on the types of fires specified below and as defined in Chapter 3 of the current edition of AC 20-42.

a. Carbon dioxide - Class B or C.

b. Water/aqueous based extinguishing agent - Class A.

c. Dry chemicals - Class A, B, or C.

d. Halogenated hydrocarbons (halon) - Class A, B, or C.

e. Specialized dry powder - Class D.

NOTE: Only “all purpose” or A, B, C dry chemical powder extinguishers containing monoammonium phosphate have a UL Class A, B, C rating; all other powders have a Class B, C rating only.

3. Numeral Ratings. Extinguishers labeled for Class A and Class B fires use numerals with the identifying letters. The numeral indicates the relative extinguishing effectiveness of the device on a given size fire, which is dependent on the agent, the capacity of the device, discharge times,

and design features. For example, an extinguisher rated as 4A should extinguish about twice as much Class A fire as a 2A rated extinguisher. A 2½-gallon water extinguisher is rated 2A. On an extinguisher rated for Class B fires, the numeral rating precedes the letter "B." Extinguishers labeled for Class C or D fires do not use numeral ratings. Extinguishers that are effective on more than one class of fires have multiple numeral-letter and letter classifications and ratings: for example, 5B:C.

4. Helpful Hints in Extinguishing Fires.

a. Generally, you can obtain the best results in firefighting by attacking the base of the fire at the near edge of the fire and progressing toward the back of the fire by moving the fire extinguisher nozzle rapidly with a side-to-side, sweeping motion.

b. The effective discharge time of most hand-held fire extinguishers ranges from 8 to 25 seconds depending on the capacity and type of the extinguisher. Because of this relatively short effective time span, the crewmember must select and use the proper fire extinguisher without delay.

c. Care must be taken not to direct the initial discharge at the burning surface at close range (less than 5 to 8 feet) because the high-velocity stream may cause splashing and/or scattering of the burning material.

d. Ventilate the compartment promptly after successfully extinguishing the fire to reduce the gaseous combustion and gases produced by thermal decomposition.