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The Future of Aircraft Cabin Fire Safety

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The Future of Aircraft Cabin Fire Safety

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Introduction:

The Fire Safety Branch at the Technical Center in Atlantic City New Jersey is the Federal Aviation Administration's (FAA) Research and Development (R&D) organization responsible for providing data to the regulatory organizations within the FAA for their use in developing, modifying and/or interpreting rules and regulations pertaining to aircraft fire safety. The Fire Safety Branch for developed many of the fire safety standards adopted by civil aviation authorities throughout the world and is presently involved in R&D for future improvements.

Background:

Over the past several years the FAA and most other aviation authorities world wide have implemented numerous modifications to aircraft fire safety standards. Those modifications have vastly improved fire safety in transport aviation and include the following:

Seat Cushion "Fire Blocking" Rule. This rule requires that all cabin seat cushions in transport aircraft meet a large oil burner test. The result of this rule change was that most seat cushions were "fire blocked". The term fire blocking refers to encapsulating and protecting the relatively flammable urethane foam with a very fire resistant material. The fire blocker is usually a separate material, placed over the urethane foam and under the outer dress cover. The fire blocking materials presently available, can not be dyed, therefore they are not used as outer covers. Until recently, urethane foam, the only foam meeting airline operational requirements, could not be made fire resistant enough without a large, and unacceptable, increase in weight. The safety benefits of this rule have be documented in accident investigations. In one case, Delta 727 in Dallas Texas, August 31,1988, it was cited by investigators as having provided a longer evacuation time, thus saving many lives.

Floor Level Lighting Rule. This is a requirement for emergency lighting near the floor in an aircraft. As a result, most airline have installed floor track lighting (light strips on the floor).

Low Heat/Smoke Release Panel Rule. This is a requirement for large surface materials in an aircraft cabin (ceiling, sidewall, stowage bins, partitions etc.), in newly manufactured or totally refurbished aircraft. It has also been referred to as the "OSU Rule" because of the test method required. This rule forced the airframe manufacturers to upgrade most of the materials used in aircraft interiors.

Cabin Fire Extinguisher Rule. A requirement of transport aircraft to carry at least two Halon 1211 extinguishers. The successful extinguishment of a hidden fire by crewmembers using Halon 1211 extinguishers may have prevented a catastrophic inflight fire in a Delta L1011 flying over the North Atlantic during March of 1991.

Lavatory Smoke Detection/Extinguishment Rule. This rule requires smoke detectors in all transport aircraft lavatories as well as a fixed extinguisher (known as a potty bottle) in all lavatory trash receptacles. The main job of these systems is the protection against people smoking in the lavatory.

Radiant Heat Resistant Evacuation Slide Requirement. This was a change to the Technical Standard Order (TSO) that containes the requirements for emergency evacuation slides. The change incorporated a radiant heat test for slide material, designed to improve the ability of slide to resist the heat from a large fuel fire nearby and remain inflated longer.

Cargo Compartment Rules. There have been three major rule changes effecting cargo compartments on transport category aircraft. The first was a change to newly certificated aircraft only. It reduced the allowable size of a class "D" compartment to 1000 cu. ft., and imposed a new fire burnthrough resistance test method for cargo liners, seams, joints, and fastening systems. The second rule change was a retroactive rule requiring the modification of class "C" and "D" compartments. This rule has lead to the removal of Kevlar and Nomex liners, the redesign of some fixtures and fastening systems, and new methods for patching damaged liners. The third rule change was an airworthness directive (AD) changing the requirements for class "B" (Combi) cargo compartments.

It should be noted that the focus for improvements in fire safety has been in the area of materials flammability upgrading.

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Materials Upgrade:

Most of the material flammability upgrading to date has been aimed at the post crash fire. New design standards are based on a fire entering the aircraft cabin from a large external fuel fire, and spreading on the interior cabin materials. Although there are still some areas such as the seat components, curtains, and transparent fixtures that should be studied to determine if upgrading of standards would increase safety, initial full scale tests have indicated that incremental changes would lead to little improvement. Therefore, near term, there seems to be limited safety improvement that could be expected from cabin material flammability upgrades against the post crash fire.

Therefore, long range R&D will center on highly fire resistant (almost non combustible) materials.

Although the materials in the cabin have been upgraded, and fire safety greatly improved, little has been done to the materials that are the most likely to be involved in an inflight fire, of concern are the hidden materials-materials behind the side wall, over the ceiling, and below the floor. Full scale tests have shown the presently used thermal acoustic insulation will not propogate a small fire. However, a small amount of contamination, such as oil, grease, lint etc.,causes the insulation blankets to become involved. That has been the case in actual inflight fire incidents.

Wire and cable has also been the source of a number of inflight smoke and fire problems. At present, the only test requirement is a Bunsen burner test for flammability. Work is presently underway to upgrade that requirement, and to develop meaningful smoke and arc tracking test procedures.

Burn Through Requirements:

In some accidents, British Airtours 737, Manchester, United Kingdom, August 22, 1985 for example, the external fire entered into the cabin by burning, or melting though the fuselage. Full scale experiments have been conducted at the Technical Center to determine the modes of hazard entry into an aircraft cabin from an external fuel fire. Work to date indicates the the most vulnerable area is the lower quadrant or areas with little or no thermal acoustic insulation. Hazard entry into the cabin is initially in the form of smoke, followed by flames through the air return grills at the cabin floor level. A Civil Aviation Authority (U.K.) program is now underway to develop a test method to evaluate burn through improvements.

Systems Approach:

Since a giant step has been taken in upgrading material standards, and further improvements in that area will not solve the entire problem (cabin furnishings do not effect the smoke, heat and flames entering the cabin from the external fuel fire) one must consider the other fuel sources on board, such as jet fuel, hydraulic fluid, passenger carry on materials and oxygen. What can be done to improve fire survivability? Have we gone far enough?

Examination of past accidents and full scale testing suggests that improvement to oxygen and hydraulic systems could improve both inflight and post crash fire safety. Oxygen systems have been the cause of aircraft fires (ATA DC10 in Chicago, August 1986 and Delta 727 in Salt Lake City, October 1989), and have contributed to the severity of post crash fires (USAir 737 in Los Angles, February 1991). For the near term, methods of containment (such as flow restrictors, fuses, or solid oxygen generation systems), should be explored. The final answer may be an oxygen nitrogen separation system. These systems (OBOGS-Onboard

Oxygen Generating System) are presently available, however, with an extreme weight penalty. Long term R&D is needed to reduce the weight to output ratio.

Hydraulic fluid has also contributed to both post crash (Korean Airlines 747, Seoul, November 1980) and inflight (America West 737, Tucson, January 1990) fire hazards. Work should be carried out to develop noncombustible fluids that meet the requirements of the transport airline industry.

Even with improvements to present systems there is still the problem of the fuel fire. How can the hazards of the external fuel fire spreading into the passenger cabin be reduced? One method that is presently being studied and shows great promise is a cabin water spray system. The idea was popularized by a company called "SAVE" in the U.K.. The system would consist of a fixed quantity of water stored onboard the aircraft that would be discharged from nozzles throughout the cabin in the event of a post crash fire. Testing to date has shown the system to be extremely effective, reducing the hazards in a cabin and extending survival time, for most post crash fire scenarios. The hazards associated with accidental discharge inflight have been studied by Airbus and Boeing. Current FAA work is on optimizing the system, or reducing the weight penalty. Based on recent optimization test results, a system for an aircraft the size of a 737 would require approximately 25 gallons of water, to protect an airplane broken into 3 pieces. The next step is to develop design requirements and specifications.

Additional Problems:

With the banning of ozone depleting CFC's the aviation industry faces additional problems. Those problems are two fold. First, CFC's are no longer being use as propellents in aerosol cans. The replacement propellents used are butane and propane, which are highly flammable. This presents a major problem in cargo compartment fire protection. Solution options are to redesign some cargo compartments or redesign the aerosol cans. Second, the extinguishing agents used in transport aircraft are CFC's (actually halogenated hydrocarbons, or Halons) and are also on the list of agents to be baned. There is a need to develop Halon recycling techniques and new non-ozone depleting agents.

Conclusion:

There are still major improvements that can be made in aircraft fire safety; however, a systems approach is needed to identify and develop cost-effective solutions.