Dousing the FLAMES

FedEx is equipping its aircraft with an automatic fire-suppression system — a first for transport category cargo airplanes.

BY LINDA WERFELMAN

For years, aviation safety advocates have decried the absence of any requirement for active fire-suppression systems on the main decks of transport category cargo airplanes.

The U.S. National Transportation Safety Board (NTSB) has repeatedly issued safety recommendations calling for the installation of such systems, which currently are required by the U.S. Federal Aviation Administration (FAA) only in the cargo compartments of passenger aircraft — not in the Class E cargo compartments most common in U.S. cargo airplanes.

Now FedEx Express, after 10 years of design and development, has begun installing the industry's first on-board automatic fire-suppression system in the airplanes used for its

Fed Ex's fire-suppression system includes an overhead cargo-container injector.

international overwater flights.[1] By late November, the system had been installed on eight FedEx McDonnell Douglas MD-11 freighters, said Bruce Popp, manager of strategic project engineering for FedEx Express.

"We plan to install the fire-suppression system on all of our fleet that fly to international destinations — aircraft that cannot land quickly should a fire take place," Popp said. Installations are being performed at a rate of about one a month, but that pace is likely to increase on the 59 MD-11s and 30 Boeing 777s, and the work is likely to be completed by early 2011, he said.

FedEx describes the system as "a network of infrared thermal sensors, foaming-agent generators and an overhead cargo-container injector." Key elements of the system are its automatic operation, which requires no initiating action by the crew, and the overhead positioning of the extinguishing agent.

If the sensors detect heat in one of the cargo containers, the fire-suppression equipment located above the container is activated and the crew is alerted. An overhead injector pierces the container and fills it with an argon-based foam that extinguishes the fire within several minutes.

The argon foam — biodegradable and noncorrosive, and often the fire-extinguishing agent of choice when damage to electronics and other sensitive equipment must be avoided — does not harm the contents of the container, and other containers in the same airplane are unaffected by activation of the fire-suppression system.

In tests, including those that were conducted as part of the certification process that preceded the FAA's 2006 issuance of a supplemental type certificate (STC) approving FedEx's installation of the equipment, the fire-suppression system quickly extinguished three classes of fires: Class A fires involving ordinary materials such as paper or lumber; Class B fires involving gasoline, kerosene and other flammable or combustible liquids; and Class D fires involving lithium, magnesium, titanium, potassium, sodium and

Argon-based foam is used to extinguish flames within minutes.

other combustible metals that burn at very high temperatures.[2] The FedEx system is the only system currently in use that is effective against Class D fires, the company said.

Electrical equipment — present in a Class C fire —is transported separately, in the lower belly of an aircraft, where Halon bottle fire-extinguishing systems are used.

Because the fire-suppression system is not designed for palletized cargo, FedEx has developed another method of controlling fires, wrapping a fire-retardant blanket around pallets to restrict the amount of oxygen inside. By limiting the oxygen that would feed the fire, the blanket keeps the fire smoldering for at least three to four hours — long enough to allow flight crews even on FedEx's longest overwater routes to divert to an alternate airport and conduct a safe landing.

20 Percent

Data show that 20 percent of all air cargo accidents from 1990 to 2006 involved fire,[3] and Dave Wells, a captain and the FedEx Central air safety chairman for the Air Line Pilots Association, International (ALPA), said that, of six FedEx hull losses, five resulted from fires.

One of the more recent fire-related air cargo accidents involved a United Parcel Service (UPS) McDonnell Douglas DC-8-71 whose three-member crew scrambled from the burning airplane after an emergency landing at Philadelphia International Airport on Feb. 7, 2006. The crewmembers suffered minor injuries from smoke inhalation and the airplane was destroyed. Fire damage was so extensive that the NTSB was unable to identify the ignition source ("Cargo Airplane Fires," p. 42).[4]

The NTSB blamed the absence of a fire-suppression system for the destructiveness of the fire and issued a safety recommendation calling on the FAA to require the installation of fire-suppression systems in the cargo compartments of all cargo aircraft operated under Federal Aviation Regulations Part 121 air carrier operations. The systems have been required since 1998 in the cargo compartments of passenger aircraft.

"The accident airplane was not required to be equipped with a fire-suppression system, and, as a result, the fire, which began as a smoldering fire in one of the cargo containers, was able to develop into a substantial fire that burned through the container and ceiling liner while the airplane was airborne," the NTSB said in the Dec. 17, 2007, safety recommendation. "The Safety Board has had longstanding concerns about the lack of fire-suppression systems in cargo compartments."

In its recommendation, the NTSB acknowledged the FedEx actions to voluntarily develop a fire-suppression system, adding that installation of the systems could mitigate the threat from cargo fires.

In response to the recommendation, the FAA, along with the U.K. Civil Aviation Authority, ordered a study of the likely effects of implementing the recommendation, including a cost/benefit analysis. The study, released in April 2009, focused on Halon fire-extinguishing systems and concluded that their installation likely would be beneficial in reducing fatal and serious injuries, as well as damage to the aircraft, its cargo and property on the ground.

Earlier Crashes

The impetus for the FAA's requirement for smoke-detection and fire-suppression systems for cargo compartments in passenger aircraft was the May 11, 1996, crash of a ValuJet DC-9 in the Florida Everglades.[5] The airplane was destroyed in the crash and all of the 105 passengers and five crewmembers were killed.

As a result of its investigation of that crash, the NTSB called for smoke-detection and fire-suppression systems for all Class D cargo compartments — on cargo airplanes as well as passenger airplanes. The subsequent FAA rule change dealt only with passenger airplanes, however.

The agency also turned aside a 1998 NTSB recommendation — issued after a 1996 fire that destroyed a FedEx DC-10 — that called for onboard fire-extinguishing systems "if they were deemed feasible."

Cargo Airplane Fires

The following are major fire-related accidents in U.S.-registered cargo airplanes:[1]

- A United Parcel Service (UPS) McDonnell Douglas DC-8-71 was destroyed by fire after an emergency landing at Philadelphia International Airport on Feb. 7, 2006. The three flight crewmembers suffered minor injuries from smoke inhalation. The U.S. National Transportation Safety Board (NTSB) did not determine the cause of the fire but said that "the presence of a significant quantity of electronic equipment in the containers where the fire most likely originated led the Safety Board to closely examine safety issues involving the transportation of rechargeable lithium batteries on commercial aircraft, including batteries in airline passengers' laptop computers and other personal electronic devices."
- A Fokker F27-500 on a FedEx flight operated by Mountain Air Cargo from Buenos Aires to Porto Alegre, Brazil, was destroyed by fire on April 27, 2004. The crew diverted to Melo, Uruguay, after a crewmember discovered the fire in the cargo bay but was unable to extinguish it. No one was injured. The cause of the fire is unknown.[2]
- A FedEx McDonnell Douglas DC-10 was destroyed by fire Sept. 5, 1996, after an emergency landing at Newburgh/Stewart International Airport in Newburgh, New York, U.S. The airplane was at Flight Level 330 (about 33,000 ft) on a flight from Memphis, Tennessee, to Boston when the crew determined that there was smoke in the cabin cargo compartment and diverted to Newburgh. The final report by the NTSB said that the fire continued burning for about four hours after smoke was first discovered and that the most severe heat and fire damage was in a container that contained flammable liquids. Two of the five crewmembers received minor injuries; the others were uninjured. The NTSB said that the probable cause of the accident was "an in-flight cargo fire of undetermined origin."[3]
- A Pan American World Airways Boeing 707 was destroyed by a fire on Nov. 3, 1973, when it crashed short of the runway on final approach to an emergency landing at Logan International Airport in Boston. The crew reported smoke in the cockpit about 30 minutes after departure from Kennedy International Airport in New York. The source of the smoke was not determined, but the NTSB said that it believed that "the spontaneous chemical reaction between leaking nitric acid, improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package initiated the accident sequence." All three crewmembers were killed in the crash.

Notes

1. U.S. Federal Aviation Administration; U.K. Civil Aviation Authority. *A Cost-Benefit Analysis for the Installation of Fire Suppression Systems in Cargo Compartments of Cargo Airplanes*, DOT/FAA/AR-09/17. April 2009.
2. Aviation Safety Network. Accident Description. < http://aviation-safety.net/database/record.php?id=20040427-1>.
3. NTSB. Accident report no. DCA96MA079.

The FAA responded that existing procedures "regarding ventilation and depressurization were sufficient means to control a fire until the flight could land and that an on-board suppression system would add 'considerable' weight to the airplane and reduce the amount of cargo that could be carried on board."

According to some calculations, under current FAA procedures, the flight crew of an airplane with an on-board fire has about 30 minutes to safely land the airplane. However, the FAA says in AC 128-80, *In-Flight Fires*, that the available time may be much less — as little as 15-20 minutes if the fire progresses without intervention.[6]

An Aircraft-Based System

When the NTSB issued its recommendation in 2007, FedEx researchers already had been working for eight years to develop an effective fire-suppression system — and had already received the FAA's STC that paved the way for installation of the fire-suppression systems.

Their studies began in 1999, Popp said, and they initially focused on how to protect individual containers against fire.

"Because we have over 40,000 containers in our system, we quickly realized that the system must be aircraft-based to be viable," he said.

Their first efforts involved a combination of Halon bottles and an alerting system; another would have incorporated pyrotechnic gas generators, which extinguish flames by releasing nitrogen gas when they come in contact with fire.

In 2001, they began exploring the aircraft-based system that they eventually adopted.

"We first needed to develop a sensor that could pinpoint the location of the fire," Popp said. "Then we discovered that Halon was unsuitable for our purpose and we needed to develop a more effective agent, and finally we needed to develop a means to insert the agent into the offending container, with no additional involvement on the part of our loading crews or our pilots."

In final tests, the fire-suppression system succeeded each time in extinguishing the blaze, not just suppressing it for a limited amount of time, Popp said.

Notes

1. The FedEx Express team that developed the fire-suppression system — Joel Murdock, Bruce Popp, Jeff Peltz, Mark Petzinger and Art Benjamin — was recognized by Flight Safety Foundation in October 2009 with the annual Honeywell *Bendix Trophy for Aviation Safety*.
2. FAA. Advisory Circular (AC) 20-42C, *Hand Fire Extinguishers for Use in Aircraft*. March 7, 1984. The classes of fires are defined by the U.S. National Fire Protection Association and in this AC by the FAA. A revision, AC 20-42D, was published for comment in the Federal Register on Oct. 13, 2009.
3. Rosenkrans, Wayne. "Burning Issues." *AeroSafety World* Volume 3 (January 2008): 36–41.
4. NTSB. Aircraft Accident Report NTSB/AAR-07/07: "Inflight Cargo Fire; United Parcel Service Company Flight 1307; McDonnell Douglas DC-8-71E, N748UP; Philadelphia, Pennsylvania; February 7, 2006."
5. NTSB. *In-Flight Fire and Impact With Terrain, ValuJet Airlines Inc., Flight 592, DC-9-32, N904VJ, Everglades Near Miami, Florida, May 11, 1996*. Aircraft Accident Report NTSB/AAR-97/06. The NTSB said that the crash resulted from a fire in the Class D cargo compartment that was ignited by "one or more oxygen generators being improperly carried as cargo." Probable causes of the accident were that the unexpended generators were improperly prepared, packaged and identified before they were delivered to ValuJet; that ValuJet did not properly oversee its contract maintenance program involving hazardous materials requirements; and that the FAA had failed to require smoke-detection and fire-suppression systems in Class D cargo compartments.
6. FAA. *In-Flight Fires*, AC 120-80. Jan. 8, 2004.

Further Reading From FSF Publications

Cox, John. "No Smoking in the Cockpit." *AeroSafety World* Volume 4 (January 2009): 31–34.

Lacagnina, Mark. "Fire in the Hold." *AeroSafety World* Volume 3 (April 2008): 28–33.

Rosenkrans, Wayne. "Thermal Runaway." *AeroSafety World* Volume 3 (March 2008): 42–48.

Lacagnina, Mark. "Balancing Cargo Safety." *AviationSafety World* Volume 1 (November 2006): 28–33.

Sarkos, Constantine P. "FAA Proposes New Rules on Cargo Compartment Fire Detection and Suppression." *Cabin Crew Safety* Volume 31 (November–December 1996).

Cargo operators interested in ordering the FedEx fire suppression system for McDonnell Douglas MD-11s or MD-10s, or Douglas DC-10s should contact Ventura Aerospace in Van Nuys, California, U.S. Additional information is available at <www.venturaaerospace.com>.

Fire-suppression foam smothers flames without harming the contents of a cargo container.

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