FIRE in the HOLD

The DC-8 flight crew received little warning of the impending conflagration.

BY MARK LACAGNINA

Philadelphia Fire Department

Twenty-five minutes after the flight crew detected a faint odor like burning wood, their 40-year-old freighter was doomed by a raging cargo fire. On final approach to Philadelphia International Airport near midnight Feb. 7, 2006, the crew of the McDonnell Douglas DC-8-71F was running out of time. There was little, if any, prospect of a successful go-around.

"They didn't have minutes. This flight was seconds from disaster," said Deborah Hersman, a member of the U.S. National Transportation Safety Board (NTSB), during the board's public meeting on the accident in December 2007.

Billowing smoke blinded the three crewmembers soon after they brought the airplane to a stop on the runway. They escaped with minor injuries from smoke inhalation. The DC-8 was a total loss, and most of the cargo aboard the airplane was destroyed or damaged by the fire. In its final report, NTSB blamed the fire for the accident but said that the ignition source could not be determined "due to the destruction of potentially helpful evidence."

"Contributing to the loss of the aircraft were the inadequate certification test requirements for smoke- and fire-detection systems, and the lack of an on-board fire-suppression system," the report said.

The DC-8, operated as Flight 1307 by United Parcel Service (UPS), was inbound to Philadelphia from Atlanta. The flight crew were working the second day of a five-day sequence. They had flown the DC-8 from Atlanta to Philadelphia and back to Atlanta the night before the accident.

The captain, 59, had about 25,000 flight hours, including 16,000 flight hours as a DC-8 pilot-in-command. He was hired by UPS in 1988. The first officer, 40, had 7,500 flight hours, including 2,100 hours as a DC-8 second-in-command. He joined UPS in 1996. The flight engineer, 61, had 9,000 flight hours, including 430 flight hours as a DC-8 flight engineer. He was employed by UPS in 1994.

The captain and the first officer told investigators that they had difficulty transitioning from their daytime off-duty schedules to their nighttime work schedules. The captain had slept about six hours the morning of the accident flight. The first officer said that he had slept about two hours that morning and "napped for a few hours in the afternoon." The flight engineer said that he had followed his normal layover routine, sleeping about five hours in the morning and napping for about two hours in the evening, and that he felt rested for the flight. The report said, however, that there was no evidence that the flight crew's performance was degraded by fatigue.

'Smells Like Wood Burning'

Nighttime visual meteorological conditions prevailed when the DC-8 departed from Atlanta at 2241 local time. The first officer was the pilot flying. The crew said that the flight was uneventful until they began the descent from cruise altitude — Flight Level (FL) 330 (about 33,000 ft) — about 157 nm (291 km) southwest of Philadelphia. The airplane was descending through FL 310 at 2334 when the first officer said, "Smells like wood burning. Smell that?"

"I smelled it for a couple of seconds," the flight engineer said.

"It's pretty strong now," the first officer said.

The flight engineer vacated his seat and pulled open the left side of the smoke curtain, a ventilation barrier that covers the netting between the galley and the main (upper) cargo compartment. The compartment holds 18 cargo containers and is not accessible after the cargo containers are loaded. A smoldering fire had begun inside a container near the back of the compartment.

The flight engineer used a flashlight to inspect the left wall of the compartment. "He stated that he could smell the odor but that he did not see any smoke or fire," the report said.

The captain considered diverting the flight to a nearby airport but decided to continue to Philadelphia. The report said that this decision was "not inappropriate," considering the circumstances: There was no visible smoke, and no annunciator lights had illuminated to warn of smoke or fire in a cargo compartment. "Further, the flight crew stated that unusual odors could be common from nonthreatening factors, such as flying over forest fires or unusual cargo," the report said.

McDonnell Douglas DC-8-71F

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Douglas Aircraft Co. began production of the DC-8, its first jet transport, in 1959. The first five versions of the DC-8 have the same overall dimensions. In 1965, a stretched version, the DC-8-61, was introduced. Douglas merged with McDonnell Aircraft Corp. in 1968.

In 1981, the DC-8-61's four Pratt & Whitney JT3D engines were replaced with CFM International CFM56s; the re-engined airplane is called the DC-8-71. The -71F is the freighter version and has an upward-hinged cargo door on the left side of the forward fuselage. Cargo capacity is 8,810 cubic ft (247 cubic m). Maximum landing weight is 258,000 lb (117,029 kg).

Source: *Jane's All the World's Aircraft*

Inappropriate Checklists

There were no specific procedures in the aircraft operating manual (AOM) for responding to an unusual odor in the absence of a warning light. The AOM contained four checklists that dealt with smoke, fire or fumes, but none was appropriate for the situation, the report said. The checklists were titled "Fire," "Fumes Evacuation," "Lower and/or Main Cargo Compartment Smoke" and "Pack Smoke."

The DC-8 was about 65 nm (120 km) from Philadelphia, descending through FL 180, at 2343, when the flight engineer announced that he had set the air-conditioning packs to maximum flow and had turned off the recirculation fan. The report said that these actions, performed in accordance with the "Fumes Evacuation" checklist, exacerbated the situation by increasing airflow in the cargo compartment. The increased airflow diluted the smoke, inhibiting its detection, and provided additional oxygen to the fire.

The AOM did not specify when the "Fumes Evacuation" checklist should be used, the report said, noting that the checklist is appropriate when fumes "cause irritation or otherwise prevent the flight crew's ability to operate the airplane."

The report discussed an international project sponsored in 2004 by Flight Safety Foundation to improve guidance for air carrier pilots in responding to nonalerted smoke/fire/fumes events. Project participants developed the *Smoke/Fire/Fumes Checklist Template*, as well as directions for completing the checklist with information provided by the airplane manufacturer and guidance on using the checklist in conjunction with other checklists in the AOM (*Flight Safety Digest*, 6/05, p. 31).

"The initial steps of the proposed checklist consist of a series of simple, rapid actions to address the most likely sources of fire," the report said. "The guidelines state that these actions should require no decision making by the flight crew, be airplane-specific and be determined by the manufacturer based on event history for each specific model airplane.

"According to the proposed checklist guidelines, unless clear visual evidence exists that all fire hazards are resolved after the initial steps, the flight crew should initiate a diversion and … not delay landing to continue the checklist for additional source identification and/or source isolation or elimination."

Boeing, which merged with McDonnell Douglas in 1997, is using the checklist template to develop new procedures related to nonalerted smoke, fire and fumes, the report said. The checklists will be available for most current models but not for older models such as the 707, 727, DC-8, DC-9 and DC-10. The report said that operators of these models will have to work with the manufacturer and the U.S. Federal Aviation Administration (FAA) to develop their own checklists for the airplanes.

In one of the many recommendations generated by its investigation of the DC-8 accident, NTSB called on the FAA to provide "clear guidance to operators of passenger and cargo aircraft … on flight crew procedures for responding to

evidence of a fire in the absence of a cockpit alert based on the guidance developed by the 2004 smoke, fire and fumes industry initiative."

Runway Change

At 2346, a Philadelphia approach controller told the crew to fly a heading of 050 degrees, to sequence the DC-8 for landing on Runway 27R. Reported weather conditions at the airport included surface winds from 270 degrees at 7 kt, 10 mi visibility, clear skies and a temperature of 0 degrees C (32 degrees F).

The airplane was descending through about 15,000 ft at 2347, when the captain asked the flight engineer if he could still smell the odor. "Yeah," the flight engineer replied. "Smells like it was more to the back there."

"Smells like cardboard burning, doesn't it?" said the first officer. "You didn't see smoke, though, something like that?"

The flight engineer again searched the cargo compartment with his flashlight and said that the odor was "definitely stronger in the back" but that there "does not appear to be any smoke or haze."

The airplane was descending through 3,600 ft at 2354, when the flight engineer announced that the "CARGO SMOKE" light had illuminated. The first officer announced that he was turning the airplane directly toward the airport. The captain then told the approach controller that they had the airport in sight. The controller cleared the crew to conduct a visual approach to Runway 27R and to establish radio communication with the airport tower controller.

The tower controller said that the winds were from 260 degrees at 6 kt and cleared the crew to land on Runway 27R. "Cleared to land," the captain replied. "And, uh, listen, we just got a cargo smoke indicator come on. Can we have the equipment meet us?" The controller activated the aircraft rescue and fire fighting (ARFF) alarm and told the captain that emergency response equipment would meet the airplane on landing.

Sounds recorded by the cockpit voice recorder (CVR) indicated that the first officer and the flight engineer donned their oxygen masks. Soon after the first officer called for landing gear extension and the "Landing" checklist at 2355, the flight engineer announced that the "LOWER CARGO FIRE" light had illuminated, warning of smoke/fire in the lower cargo area, which comprises four cargo compartments.

"Oxygen masks on if you don't have them," the captain said. "And run through that checklist by yourself, OK?" The flight engineer verbalized his actions while conducting the "Lower and/or Main Cargo Compartment Smoke or Fire" checklist.

At 2356, the tower controller cleared the crew to land on the parallel runway, 27L, which is designated by the airport emergency plan for use in emergencies. "UPS thirteen oh seven heavy is cleared to land runway two seven left," the controller said. "The wind is two six zero at six." The controller did not, and was not required to specify that the landing runway assignment had been changed. The CVR recording indicated that the captain had his oxygen mask on when he acknowledged the clearance to land on Runway 27L; he said nothing about the change in runway assignment, however.

'Have to Do an Evacuation'

The "Lower and/or Main Cargo Compartment Smoke or Fire" checklist required the flight

"We just got a cargo smoke indicator come on. Can we have the equipment meet us?"

Philadelphia Fire Department

engineer to vacate his seat so that he could open an access panel on the wall behind the cockpit bulkhead and close the cargo air valve. Black smoke billowed out when he opened the access panel. After closing the cargo air valve, he announced that he had seen smoke. "We're going to have to do an evacuation, OK?" he said. "Tell them we are going to have to do an evacuation when we get down."

The captain and first officer were finishing the "Landing" checklist at 2358, when the tower controller asked the crew to confirm that they were landing on Runway 27L. "It appears you are lined up for the right," the controller said.

"I'm sorry," the captain replied. "I thought we were cleared for the right. Are we cleared to land on the right?"

"You are cleared to land on the right," the controller said. "We will just tell fire [i.e., ARFF personnel]."

"The change in landing runways — from 27L to 27R — resulted in a subsequent change in standby positions," the report said. "ARFF personnel reported that the change in runways resulted in a 60- to 90-second delay in responding to the accident scene. Seven [airport] ARFF vehicles responded."

The DC-8 touched down on Runway 27R at 2359. "Immediately after touchdown, the flight engineer reported smoke in the cockpit," the report said. "After the airplane came to a stop [on the runway], the first officer called for an emergency evacuation, and the captain and first officer conducted the 'Emergency Evacuation' checklist." The smoke had become so dense that the pilots could not see each other.

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U.S. National Transportation Safety Board

"The first officer stated that, after he transmitted to the [tower controller] that they were evacuating the airplane, the smoke was so heavy that he could not see his hand in front of him," the report said.

Both the captain and the first officer attempted to retrieve the "Notice to Captain" (NOTOC), a document that contains information about the locations and types of hazardous material being shipped aboard the airplane; however, they were unable to find it. During the flight, the NOTOC had fallen from its storage area behind the captain's seat, and the flight engineer had placed it on a bulkhead at his station.

The flight engineer took a breath of oxygen from his mask before leaving his station to deploy the emergency slide for the left forward door. All three crewmembers used the slide to evacuate the airplane.

The captain told ARFF personnel that there were hazardous materials aboard the airplane and that he had not been able to locate the NOTOC. The three flight crewmembers then were transported to a local hospital and treated for smoke inhalation.

A firefighter located the NOTOC about 35 minutes after ARFF personnel began fighting the fire with water and aqueous film-forming foam. "The first fuselage burn-through occurred about 0200 and was located in the crown of the fuselage aft of the wings," the report said. "The fire was characterized as being 'fully involved' around 0220. ARFF personnel reported that the fire was under control about 0407."

Twenty-Minute Delay

The DC-8 model originally was certified to the transport category airplane airworthiness standards of U.S. Civil Aviation Regulations 4b, which was recodified as Federal Aviation Regulations Part 25 in 1965. The accident airplane was manufactured in 1967 and purchased by UPS in 1985. It had accumulated about 67,675 flight hours when the accident occurred.

Examination of the airplane's smoke-detection system revealed no anomalies. There are seven smoke detectors on the ceiling of the main cargo compartment and 19 in the lower compartment.

Investigators determined that the fire likely began inside cargo container 12, 13 or 14

(Figure 1). Among the items that had been shipped in these containers were electronic devices, including laptop computers, with rechargeable lithium batteries. Several lithium batteries of the same type also were found loose in the accident debris.

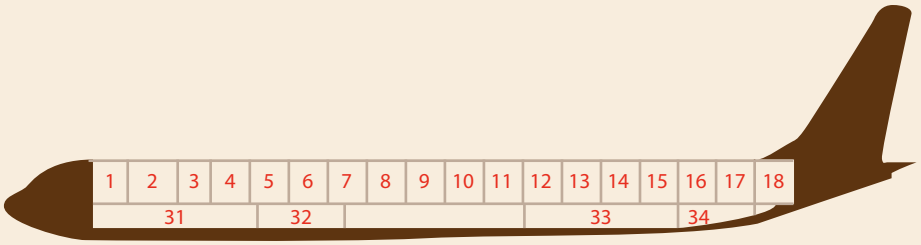
Noting that "testing and incident data indicate that lithium batteries can pose a fire hazard," the report said there was no evidence that lithium batteries were the source of ignition aboard the DC-8.

"A review of FAA and CPSC [Consumer Product Safety Commission] records shows that the number of … lithium-battery-related incidents — many of which involved laptop computer fires that resulted from either internal or external short-circuiting of [rechargeable] lithium batteries — has increased consistently over the years," the report said. The accident investigation generated several recommendations designed to prevent such incidents (*ASW*, 3/08, p. 42).

Investigators determined that the smoke-detection system aboard the DC-8 did not perform according to applicable certification standards, which require an "acceptable indication to the crew" no more than five minutes after smoke is initiated in a cargo compartment. The flight crew received the first smoke warning 20 minutes after the first officer detected an unusual odor related to the fire.

During the original certification tests of the DC-8's smoke-detection system, detection times varied from 12 seconds to three minutes, which were well within the existing standard. The report noted, however, that the certification tests were conducted in empty cargo compartments. This was done because the smoke would disperse in the open area, requiring greater sensitivity by the detection system. However, this method does not account for the effects of loaded cargo containers on smoke detection, the report said.

DC-8 Cargo Configuration



Note: The numbers 1 through 18 designate cargo container locations in the main cargo compartment. The numbers 31 through 34 designate lower cargo compartments.

Source: U.S. National Transportation Safety Board

Figure 1

"With cargo containers loaded in the cargo compartment, air exiting the air-conditioning vents in the ceiling is primarily directed outward and downward toward the floor [i.e., away from the smoke detectors]," the report said. "The cargo containers also create a barrier that the smoke must traverse before it enters the open space of the cargo compartment, where it can be detected by the smoke-detection system."

Current transport airplane certification standards require a crew alert within one minute of smoke generation. Nevertheless, certification tests of smoke- and fire-detecting systems still are typically conducted in empty cargo compartments, the report said.

Based on these findings, NTSB recommended that the FAA "ensure that the performance requirements for smoke- and fire-detection systems on cargo airplanes account for the effects of cargo containers on airflow around the detection sensors and on the containment of smoke from a fire inside a container."

Freighter Fire Hazards

The report noted that NTSB over the past 20 years has made several recommendations to require fire-suppression systems in air carrier cargo compartments. Following the May 11, 1996, cargo-fire-related crash of the ValuJet Airlines DC-9 in Florida (*Accident Prevention*, 11/97), the FAA issued a regulation requiring fire-suppression systems in the cargo holds of passenger-carrying airplanes.

As a freighter, the UPS DC-8 was not equipped with, and was not required to be equipped with, a cargo-fire-suppression system (*ASW*, 1/08, p. 36). "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," the report said.

The report said that the FAA rejected previous recommendations in part because it believed that fire-suppression systems would unduly add weight and reduce cargo area aboard freighters. Pointing to the recent development and testing by FedEx of a system that extinguishes fires inside cargo containers before they breach the containers, NTSB again told the FAA that all cargo airplanes should have fire suppression systems. ●

This article is based on NTSB Accident Report NTSB/AAR-07/07: "Inflight Cargo Fire; United Parcel Service Company Flight 1307; McDonnell Douglas DC-8-71F, N748UP; Philadelphia, Pennsylvania; February 7, 2006."